Summary of Progress *of the* GEOLOGICAL SURVEY OF GREAT BRITAIN *and the* Museum of Practical Geology for the Year 1930

PART I

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
1931
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Department of Scientific and Industrial Research

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of the
Geological Survey of Great Britain
and the
Museum of Practical Geology
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PART I

With Report of the
Geological Survey Board and
Report of the Director

LONDON:
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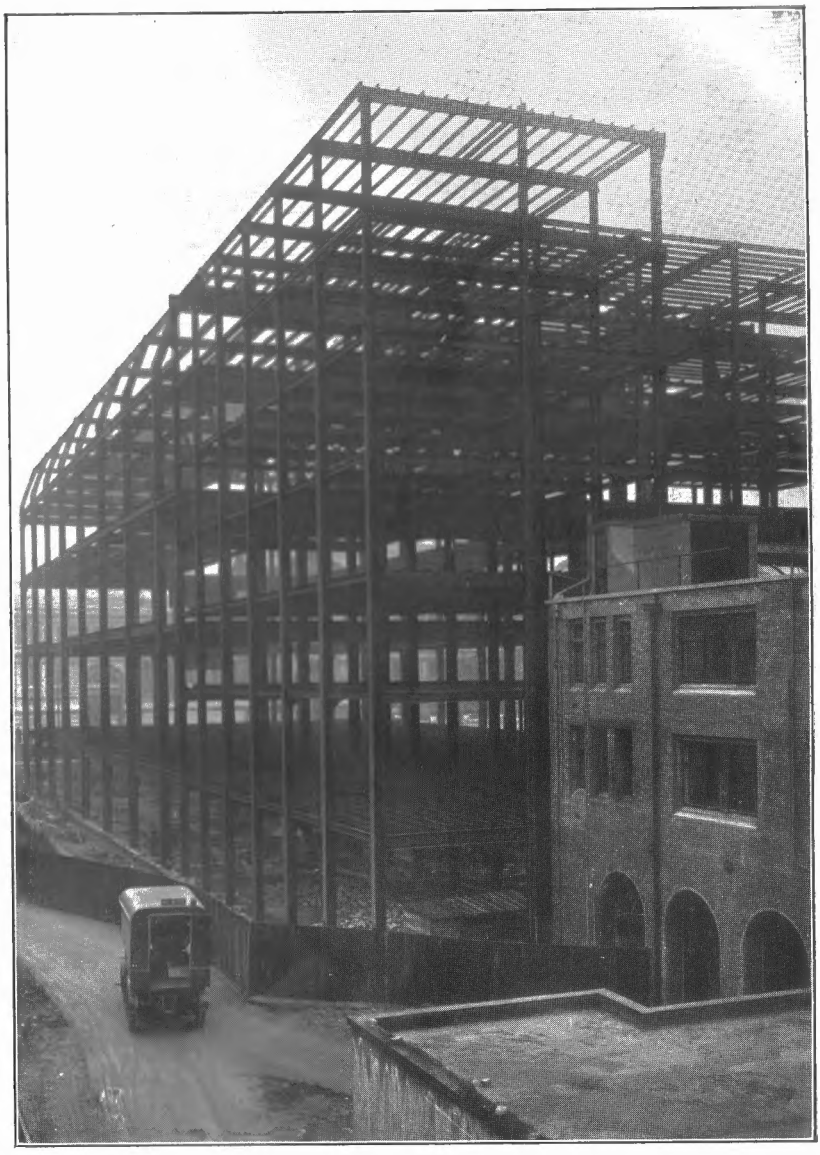
28 JAN 1952



STEELWORK OF THE NEW GEOLOGICAL MUSEUM, SOUTH KENSINGTON (PHOTO TAKEN IN JANUARY, 1931).

REPORT OF THE GEOLOGICAL SURVEY BOARD FOR 1930

TO THE LORDS OF THE COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

MAY IT PLEASE YOUR LORDSHIPS.—

In accordance with our terms of reference, we, the Geological Survey Board, beg to submit our Eleventh Annual Report on the work of the Survey and Museum.

Accommodation (London)

It is with pleasure that we are able to report that good progress is now being made with the erection of the new Offices and Museum at South Kensington. At the close of 1930 the steel framework of the building was practically complete. It is to be hoped that the rate of progress will be maintained and that the Geological Survey and Museum will be enabled thereby to move to their new home at South Kensington in the near future.

Accommodation (Scottish and Provincial Offices)

Steps have now been taken to remedy the unsatisfactory feature in the Edinburgh Office accommodation to which reference was made in our Report for 1929. A suitable storeroom for collections is being erected and should be ready for occupation in the spring of 1931.

The branch offices at Manchester, Newcastle-on-Tyne, and York are being maintained.

Field Work

The Director's Report for 1930, which is submitted herewith, shows that the stated programme of field work for the year has been carried out.

The Field Units have been engaged in the undermentioned districts :—

Southern District (primary six-inch survey).

Midlands and South Wales Districts (partly primary and partly revision of six-inch survey).

Yorkshire District (revision of six-inch survey).

Lancashire District (revision of six-inch survey).

Cumbrian District (revision of six-inch survey).

Northumberland and Durham District (revision of six-inch survey).

Renfrewshire, Lanarkshire, and Dumfriesshire District (revision of six-inch survey).

West Highland District (primary six-inch survey).

Shetland District (primary six-inch survey).

This work is in the main a continuation of that on which the Geological Survey was engaged in 1929. In the revision of the coalfields and mining districts steady and satisfactory progress continues to be made.

The year under review was marked by the resumption of work in the West Highland District and the commencement of work in the Bridport area of the Southern District. The primary six-inch survey of the West Highland District was stopped in 1923 to allow of the acceleration of the revision of the Scottish Coalfields. As this revision has now made satisfactory progress, it was decided to resume work in the West Highlands. In the Bridport area the need for an up-to-date map and memoir had long been felt.

Details of the work carried out by each of the Field Units mentioned above are given in the *Summary of Progress* (pp. 35—74).

Publications

We are pleased to note that there has been a steady flow of publication during the year. In England, two new quarter-inch maps, eight one-inch maps, and 19 six-inch maps have been published; while, in Scotland, one one-inch map, and 14 six-inch maps have appeared. The one-inch and six-inch sheets relate mainly to coalfield areas.

The output of memoirs in England, consisting of three Sheet memoirs and two Water Supply memoirs, and, in Scotland, two District memoirs and one Sheet memoir, has been quite up to the average. In addition, the Summary of Progress for 1929 was issued in three parts, one of which was devoted to administrative matter, and two to reports on a variety of geological matters arising out of the work in hand. One of the Scottish District memoirs, viz.—the Geology of Ardnamurchan, North-west Mull and Coll—is a work of high geological interest and makes a notable contribution to the literature of extinct volcanic action in the British Isles. The two published memoirs of the Water Supply series of English Counties dealt with the counties of Gloucestershire and Worcestershire.

Investigation of Building Stones

We are glad to report that progress has been maintained in the co-operative study of British Building Stones by the Geological Survey and the Building Research Station, to which attention was drawn in our Tenth Annual Report, and that the first stage of the work has been completed. Details of the work already carried out will be found in the Report of the Director (p. 24). It is gratifying to observe that the field observations carried out in this investigation have been the means of bringing together much very useful information.

Geophysical Work

Satisfactory progress continues to be made in the study of the Gravitational torsion balance and the Magnetic balance as aids to

the work of the Survey. During the year an Eötvös-Süss small torsion balance was acquired and a gravitational survey carried out in the Thrussington area of Leicestershire. Magnetic surveys were also carried out (1) on the Lornty Dyke, Blairgowrie, Perthshire, (2) at Portobello, Edinburgh, (3) at Groby, Leicestershire, and (4) at Pipewell, Northants. Accounts of this work will appear in due course.

Co-operation on Soil Surveys

We are glad to record that the Geological Survey has continued to render assistance to the Soil Surveyors. A conference at Bangor was attended by two geologists, and for the purpose of the meeting a preliminary examination of the local Drift deposits was made. Arrangements have been made for a geologist to visit in 1931, with the Soils Correlation Committee, each area in which soil investigation is proceeding. In these areas the Soils Correlation Committee, which is a Committee set up by the Ministry of Agriculture and Fisheries in conjunction with the Department of Agriculture for Scotland, is to examine a selected group of soils and to classify them.

Steps are also being taken to publish a one-inch scale Soil Texture edition of Sheet 14 (Scotland). This Sheet will correspond with that of Sheet 22 (Scotland), issued in 1929.

Collaboration

The Survey has continued to receive valuable assistance from a number of specialists outside the ranks of its own staff, and we desire to express our appreciation of the services thus rendered. Particulars are given in the Director's Report (p. 26).

Colour-Printing of Six-inch Scale Geological Maps of London

In view of the considerable number of enquiries received for large scale Geological maps of the London area a proposal to colour-print and publish in a cheap form the quarter-sheets of the populous London area was considered. At present, these maps exist only in manuscript form in the London Geological Survey Office. They are of great assistance when questions of soils, building sites, water supplies, and sanitation have to be dealt with. There is a real need for these maps and they should have a good sale if reasonably priced. We have therefore recommended the proposal.

Notification of Borings for Water

The desirability of securing powers in regard to notification and inspection of borings for water, similar to those possessed in respect of minerals under Section 23 of the Mining Industry Act (1926), and to which reference was made in our Report of last year, has received further consideration. It has, however, appeared so unlikely that the question could be successfully pursued at the present time, in view of certain legal difficulties, that the matter has been left in abeyance.

Report of 'Carpenter Committee'

A copy of the 'Report of the Committee on the Staffs of Government Scientific Establishments' issued by H.M. Treasury in 1930 was referred to the Board by the Director.

The Board gave this Report their most careful consideration and communicated their opinions thereon to the Department of Scientific and Industrial Research.

Membership of the Geological Survey Board

The retirements of Members of this Board which were foreshadowed in our last year's Report took place on the 31st March, 1930, and the undermentioned gentlemen were appointed in succession :—

Dr. T. Franklin Sibly (Chairman).
Professor R. W. Dron.
Mr. C. W. Hobley.
Professor S. H. Reynolds.

Sir Francis G. Ogilvie.—We desire to record our sense of the loss suffered by this Board by the retirement of Sir Francis G. Ogilvie from the chairmanship on the 31st March, 1930, and to express our deep regret at his subsequent death on the 14th December, 1930. Sir Francis Ogilvie had been Chairman of the Board from its inception in 1920. His deep interest in everything that concerned the welfare of the Survey, his untiring services upon the Board, and his patient advocacy in connexion with the New Museum and Offices at South Kensington, will long be remembered.

Programme of Field Work

The programme of field work for 1931 is :—

(*a*) primary mapping on the six-inch scale in the south-east of England (Sevenoaks, Saffron Walden, Biggleswade, Bridport), in the West Midlands (Droitwich), in the Shetland Islands, and in Inverness-shire ;

(*b*) revision of original six-inch mapping in the following coalfields and adjacent areas :—Lancashire, Yorkshire, Cumberland, Northumberland, Dumfriesshire, and Fife ;

(*c*) investigation of underground water-supplies, verification of bore records, examination of mineral resources, investigation of sources of building-stones, and application of geophysical methods of surveying.

T. Franklin Sibly,
Chairman.

25th *March*, 1931.

SUMMARY OF PROGRESS OF THE GEOLOGICAL SURVEY AND MUSEUM FOR 1930

I. REPORT OF THE DIRECTOR

DURING the year 1930 work was continued in all the areas in which the Geological Survey had been engaged in the previous year. Two districts, one in England and one in Scotland, were added to the list. In the Western Highlands Mr. Richey's unit, consisting of four geologists, resumed the mapping of the metamorphic and intrusive rocks around Loch Sunart and Loch Shiel (Sheet 52). Part of this ground was being surveyed in 1922 when a decision was arrived at to discontinue Highland mapping for a time in order to accelerate the completion and publication of the revised maps of the Scottish coalfields, which were urgently required. This revision is now in a satisfactory state and most of the information has been collected in the Ayrshire coalfield where that unit was employed. The six-inch and one-inch maps are published or are preparing for the press and the last of the memoirs are getting ready for printing. Although Highland work on the west coast was stopped for a time, so far as new surveying was concerned, the office work was actively pushed forward and with the publication of the Ardnamurchan memoir in 1930 the arrears have been reduced to a minimum. As field work had previously been resumed in the north-east of Scotland (Sutherland, Caithness, Orkney and Shetland) we are in a position to say that the primary survey of the Scottish Highlands is now being prosecuted as actively as in the years before the war, when this was one of the most essential features of the annual programme of work in Scotland.

During the past summer also Mr. Lloyd has finished his revision work in the Torquay district (Sheet 350) and has made considerable progress in the preparation of a second edition of the memoir on that Sheet. He has accordingly been transferred to Bridport and has started a re-survey of that ground on the six-inch scale. The maps and memoirs on that district and the adjacent Lyme Regis district are much used by students of Jurassic geology and revised editions are constantly being asked for. The discrimination of the sub-divisions and zones of the Jurassic has made so much progress since the last survey of this part of Dorsetshire that very considerable changes will probably be necessary in preparing the new maps.

Of the areas in which the Geological Survey has been at work special attention has been directed, as in previous years, to the revision of coalfields and mining districts. The demand for up-to-date and critical maps of economic areas is constant and insistent, but progress is apt to be slow as the amount of mining information that has to be collected and exhaustively studied is sometimes

extraordinarily great. A single six-inch quarter-sheet covering six square miles may contain two or three hundred borings and many mines, both active and abandoned, and the preparation of a new map of such an area involves intensive study. Such progress has now been made in the revision of British coalfields, however, that new maps are available for by far the larger part of them. These maps are now accompanied by Sheets of Vertical Sections that show in all necessary detail the complete sequence of strata in each coalfield.

In Scotland only small areas of coalfield remain to be revised as all the major productive fields have now been thoroughly investigated. A start was made during the past year with the revision of the small Sanquhar coalfield. There remain also for investigation the Limestone coalfields of the East of Fife where working has long been abandoned, and the Machrihanish coalfield in Argyllshire. As will be seen from the list of six-inch maps published during the year (p. 12) notable contributions have been made to the economic geology of Ayrshire, Lanarkshire, Kinross-shire and Fifeshire. The series of economic memoirs descriptive of these new maps is being gradually completed ; and even though publication has not yet been achieved, the information is always available to those who take occasion to consult the staff of geologists in the Edinburgh office.

In England four great coalfields have absorbed the activities of four units of the Geological Survey during the past year. Mr. Carruthers with four geologists, working from our office in Newcastle-on-Tyne, has covered a considerable area of Coal Measures on the coast near Blyth and Tynemouth, while part of his staff has been engaged in the survey of inland districts where the coals of the Lower Carboniferous are worked on a small scale. A considerable number of revised six-inch maps has been issued ; one memoir has been published and others are in preparation. This unit is advancing southwards and will gradually extend its operations to the important mining areas of County Durham.

In the Cumberland coalfields Mr. Eastwood has succeeded Dr. Bernard Smith as District Geologist and with three geologists he has been finishing the revision of the Whitehaven and Maryport coalfield in the neighbourhood of Aspatria. The remainder of this coalfield has now been revised and the maps and memoirs are published or ready for printing. As the Coal Measures around Aspatria were revised during the past field season the survey of that coalfield is complete. Many obscure problems have called for investigation during the course of the work as the geology proved intricate and perplexing. It was well known that the previous maps were in some respects unsatisfactory and no time or trouble have been spared to make the new maps as complete as possible. Memoirs have already appeared on the iron ores of Cumberland[1]

[1] 'Special Reports on the Mineral Resources of Great Britain,' Vol. VIII, Iron Ores : Haematites of West Cumberland, Lancashire and the Lake District, (*Mem. Geol. Surv.*), Edit. 2, 1924 ; and Vol. IX, Iron Ores (*contd.*) : Sundry Unbedded Ores of Durham, East Cumberland, etc., (*Mem. Geol. Surv.*), 1919.

and on the lead and zinc[1] ores, so that the economic geology of that province may be said to have been very thoroughly investigated. The adjacent coalfield of Haltwhistle, which lies on the watershed between Cumberland and Northumberland, and the coal seams in the limestone measures of that district are being dealt with in the maps and memoir of the Brampton district (Sheet 18) which will soon be issued.

The Manchester unit, working at our office in Manchester, and consisting of four geologists under Dr. W. B. Wright, is still deeply involved in the complicated geology of the mining area around Wigan (Sheet 84) and to the north of that town. A memoir on the Manchester Sheet (85) is now in the press.

The Yorkshire unit of four geologists under Mr. C. E. N. Bromehead, having finished the Glossop Sheet (86) has now begun the revision of the very important Wakefield (78) and Barnsley (87) Sheets.

A memoir on Glossop is being written but is not yet ready for printing. During the coming season an intensive study will be made of the West Yorkshire coalfield, as the three sheets above mentioned along with Huddersfield (77) cover an area that is both important and typical and when they are all completed a notable addition will have been made to our knowledge of Yorkshire economic geology. Much mining has been done in that ground since the Geological Survey prepared the maps and memoirs that are at present the principal sources of information. It is expected accordingly that the new maps will show many additions and improvements when compared with the existing ones.

In the South Wales coalfield progress has been made with the second revision of the Merthyr Tydfil area (Sheet 231). Dr. Robertson has had in hand the preparation of a new edition of the memoir on that Sheet, as the first edition has been out of print for several years. By visiting all the collieries he has collected much information and made a number of important improvements in the six-inch maps. New editions of these maps are preparing and some of them are now with the engraver. Additional light has been thrown on the palaeobotany of these Coal Measures by the researches of Dr. Crookall, and the results are sufficient to justify the work spent on the revision of the ground which was re-surveyed about 1900 by the Survey staff working under Sir Aubrey Strahan.

In the West Midlands area Dr. Bernard Smith with a staff of four geologists has completed the revision of the Shrewsbury Sheet (152) and is proceeding to the completion of the Dudley Sheet (167). Coalfield enters into both these sheets, viz., the Shrewsbury coalfield and the Coalbrookdale coalfield, and some important problems in the Carboniferous remain to be solved; but there are also many strata of great geological interest belonging to the older Palaeozoic and these are receiving close attention. Dr. Stubblefield has

[1] 'Special Reports on the Mineral Resources of Great Britain,' Vol. XXII, Lead and Zinc Ores of the Lake District, (*Mem. Geol. Surv.*), 1921.

devoted a considerable amount of time to the study of the palaeontology of these older rocks, about which there is still a good deal to be learned. When these Sheets are finished practically the whole productive area of the West of England will have been revised with the exception of the Bristol and Forest of Dean coalfields. During the past year this unit has not published a memoir or a one-inch map, but this is merely a consequence of the energy with which they have attacked the arrears of publication which were left after the war. These have now been completely overtaken and publication has been achieved of all work which had been left in an unfinished state and of much additional material that had to be collected to complete the records before publication was feasible.

In the London and South-eastern district Mr. Dewey with four geologists has continued mapping in two areas. On the one hand the ground south and east of London which had been under revision for several years has claimed attention. The Reigate Sheet (286) has been finished and is preparing for the engraver and the Sevenoaks Sheet (287) has been started. As a favourite residential area this district has always been the source of numerous enquiries regarding soils, building sites, water supplies and sanitation, and though the old maps are still useful there is no doubt that revision is completely justified. On the other hand the revision of two one-inch Sheets in the neighbourhood, of Cambridge, Saffron Walden (205) and Biggleswade (204), has been carried a step farther. One of these Sheets is now nearly completed. The demand for revised maps of this district has been strongly pressed for several years and as the revision of coalfields has been to a large extent overtaken it seems that opportunity might be taken to meet the demand. The original survey on the one-inch scale is being replaced by a new six-inch survey in which the special features of the superficial and drift deposits are being carefully recorded.

Much of the time of this unit is taken up with answering enquiries on water supply, soils, agriculture, and forestry, received daily by letter or from persons who call at the London office and library. This work is of the greatest importance as fulfilling an immediate service to the public, and is regarded as having the first claim on the attention of all members of the staff. Several hundreds of these enquiries are dealt with by the London staff every year ; and while many are of a trivial nature and easily answered others involve questions entailing the expenditure of large sums of money and require the most careful consideration.

In Scotland the primary six-inch survey has been continued actively in the Highlands during the summer season. The previous year had seen the completion of the survey of the Orkneys but some work remained to be done in collecting rocks and fossils and in taking photographs of scenes of geological interest. Mr. Wilson with five geologists has surveyed a considerable part of the county of Shetland, an area very rich in petrological and mineralogical problems. More than one half of the archipelago remains to be

surveyed and it is as yet too early to draw general conclusions regarding structure and correlation.

In the West Highlands, as mentioned above (p. 5), the primary survey of Moidart and Glen Shiel has been resumed after a stoppage of six years.

In Central Scotland some work was done in spring and autumn in the coalfields of Sanquhar, Fife and Douglas, but the revision of the Scottish coalfields is approaching completion and the time of the staff is largely occupied in studying the mining and boring records and preparing the maps and descriptive memoirs for publication.

Publications

The list of maps and memoirs published during the year is given on pages 10—12,15,16.

Maps

Two Sheets of the new quarter-inch map have been issued and four others are in the press. Besides receiving all necessary corrections to the geology these maps are being printed on a new and uniform colour scheme which has been carefully designed to give the greatest possible clearness and contrast, as these maps are frequently used for demonstration purposes and as wall maps by teachers.

Of the English New Series one-inch maps eight have been published during the year, four being ' solid ' and four ' drift ' editions. They all belong to the series of coalfield maps, as all contain working coalfields. A new ' solid ' edition of the Edinburgh Sheet (32) has also been issued containing all information acquired since the publication of the previous edition in 1910. This map follows the example of other Scottish one-inch coalfield maps, issued in recent years in being a pure solid edition from which all drift and superficial deposits have been omitted. The corresponding drift map was published in 1928.

Of the six-inch coalfield maps 19 English and 14 Scottish have been published.

Attention may also be directed to the large amount of map work which is in the press and will shortly be published. This comprises 2 English and 2 Scottish quarter-inch maps, 7 English and 11 Scottish one-inch maps, 30 English and 20 Scottish six-inch maps and 3 English and 3 Scottish Sheets of Vertical Sections. As the average time required to pass a geological map through the press is a year, or rather more, it will be seen that the geologists, draughtsmen and engravers have been very fully employed during the past twelve months.

In addition to the maps that have been published, a large number of six-inch maps has been prepared by the draughtsmen in standard form and deposited in the Library for use as reference maps by the public. These may be consulted at any time during office hours by callers at the London and Edinburgh offices. The English manuscript maps deposited during 1930 are 201 in number, the

Scottish are 14. In the Edinburgh office a new fireproof strong room with steel shelving has been provided by H.M. Office of Works for the safe custody of these manuscript reference maps or 'clean copies.'

Memoirs

The English memoirs published during the year are five in number, three being monographs on English coalfields, while two are water-supply memoirs. Of the Scottish memoirs one deserves special mention—the Ardnamurchan memoir. It is a work of high geological interest and is not only notable as a contribution to Scottish geology but extends the series of descriptive accounts of the Tertiary volcanic centres of the Hebrides, a region that has attracted the attention of many distinguished British and foreign geologists during the last hundred years. As a companion volume to the Geology of Skye, the Small Isles memoir, the Mull memoirs and the Arran memoir it will occupy an important place in the literature of extinct volcanic action in the British Isles.

Water Supply Memoirs

Two memoirs of the series on the Water Supplies of English Counties have been published during the year, viz. : Gloucestershire and Worcestershire, while a third is in the press and nearly ready for issue, viz. : Leicestershire. All these are from the pen of Mr. Linsdall Richardson, who has received much friendly assistance from County and Borough Engineers, Medical Officers of Health, District Analysts and Managers and Secretaries of Water Companies. This series of reference works undoubtedly fills a place in the literature of British hydrology, and every effort is made to secure a high standard of accuracy both in the geological and in the statistical data. Of the earlier volumes the Water Supply of Sussex sold out and a new edition has been issued. The volume on London Wells published in 1913 is now also out of print and steps are being taken to prepare a second edition.

The following maps, vertical sections and memoirs were published in 1930 :—

I.—Maps

English and Welsh Maps published in 1930

¼ inch to 1 mile :—

Sheets 9 and 10.—Barmouth, Chester, Holyhead, Shrewsbury, (1910). *Reprinted, Revised.*

Sheet 13 and part of 17.—Fishguard, Haverfordwest, Milford (1910). *Reprinted, Revised.*

1 inch to 1 mile :—

Sheet 6.—Alnwick (*Solid and Drift Editions*). Originally published as Sheet 109 N.W., Old Series. Re-surveyed by C. H. Dinham, G. A. Burnett, W. Anderson, J. Maden and R. G. Carruthers, District Geologist.

Sheet 18.—Brampton (*Solid Edition*). Original survey by R. Russell, D. Burns, T. V. Holmes, E. J. Hebert and A. Colvin. Re-surveyed by F. M. Trotter and S. E. Hollingworth; B. Smith, District Geologist.

Sheet 22.—Maryport (*Solid and Drift Editions*). Originally published as Sheet 101 N.W., Old Series. Revised by J. G. Goodchild. Re-surveyed by T. Eastwood and L. H. Tonks; B. Smith, District Geologist.

Sheet 28.—Whitehaven (*Drift Edition*). Originally published as Sheet 101 S.W., Old Series. Revised by J. G. Goodchild and A. Strahan. Re-surveyed by E. E. L. Dixon, T. Eastwood, S. E. Hollingworth and B. Smith, District Geologist.

Sheet 85.—Manchester (*Solid and Drift Editions*). Originally published on Old Series maps. Re-surveyed by L. H. Tonks, W. Lloyd, R. C. B. Jones, R. L. Sherlock and D. A. Wray; W. B. Wright, District Geologist.

6 inches to 1 mile (coalfield maps) :—

Derbyshire, 2 S.E.—Glossop. Surveyed by J. V. Stephens; C. N. Bromehead, District Geologist.

Lancashire, (89 N.E. and 89a N.W.).—Bleakedgate Moor. Original survey by E. Hull and A. H. Green. Re-surveyed by D. A. Wray; W. B. Wright and C. N. Bromehead, District Geologists.

Lancashire, 97 N.W.—Oldham. Original survey by E. Hull. Re-surveyed by W. Lloyd; W. B. Wright, District Geologist.

Northumberland, N.50 N.E.—Longframlington. Original survey by W. Topley. Revised by A. Fowler and J. Maden; R. G. Carruthers, District Geologist.

Northumberland, N. 52 S.W.—Druridge. Original survey by W. Topley. Revised by A. Fowler and J. Maden; R. G. Carruthers, District Geologist.

Northumberland, N.58 N.E.—Ewesley. Original survey by W. Topley. Revised by J. Maden; R. G. Carruthers, District Geologist.

Northumberland, N.58 S.E.—Rothley Lakes. Original survey by W. Topley. Revised by J. Maden; R. G. Carruthers, District Geologist.

Northumberland, N.59 N.W.—Nunnykirk. Original survey by W. Topley. Revised by J. Maden; R. G. Carruthers, District Geologist.

Northumberland, N.59 N.E.—Longhorsley. Original survey by W. Topley. Revised by A. Fowler and J. Maden; R. G. Carruthers, District Geologist.

Northumberland, N.59 S.E.—Stanton. Original survey by W. Topley. Revised by A. Fowler and J. Maden; R. G. Carruthers, District Geologist.

Northumberland, N.88 S.E.—Blenkinsop. Original survey by D. Burns. Re-surveyed by F. M. Trotter; B. Smith, District Geologist.

Northumberland, N.97 N.E.—Featherstone. Original survey by D. Burns and E. J. Hebert. Re-surveyed by F. M. Trotter; B. Smith, District Geologist.

Shropshire, 36 S.E.—Oakengates. Surveyed by T. H. Whitehead; T. C. Cantrill, District Geologist.

Shropshire, 43 N.E.—Stirchley. Surveyed by R. W. Pocock; T. C. Cantrill, District Geologist.

Yorkshire, 261 S.W.—Shelley. Original survey by A. H. Green, J. C. Ward and R. Russell. Re-surveyed by D. A. Wray; C. N. Bromehead, District Geologist.

Yorkshire, 272 N.E.—Holmfirth. Original survey by J. R. Dakyns and J. C. Ward. Re-surveyed by C. N. Bromehead, District Geologist.

Yorkshire, 272 S.E.—Scholes. Original survey by J. R. Dakyns and J. C. Ward. Re-surveyed by G. V. Wilson; C. N. Bromehead, District Geologist.

Yorkshire, 273 S.W.—Thurlstone. Original survey by A. H. Green, J. R. Dakyns and J. C. Ward. Re-surveyed by G. V. Wilson ; C. N. Bromehead, District Geologist.

Yorkshire, 281 N.W.—Langsett. Original survey by A. H. Green, J. R. Dakyns and J. C. Ward. Re-surveyed by G. V. Wilson ; C. N. Bromehead, District Geologist.

Scottish Maps published in 1930

1 inch to 1 mile :—

Sheet 32.—Edinburgh (*Solid Edition*). Original survey by A. Geikie and H. H. Howell. Revised by Sir A. Geikie, H. H. Howell, B. N. Peach, J. S. Grant-Wilson and H. M. Cadell. Further revision by B. N. Peach, C. T. Clough, L. W. Hinxman, J. S. Grant-Wilson, W. Gibson, E. H. Cunningham-Craig, C. B. Crampton, H. B. Muff, E. B. Bailey, E. M. Anderson and G. W. Grabham. (*New Colour-printed edition*).

6 inches to 1 mile (coalfield maps) :—

Ayrshire, 41 S.E.—Dalgig. Original survey by J. Geikie and B. N. Peach. Revised by J. B. Simpson ; E. B. Bailey, District Geologist.

Ayrshire, 52 N.E.—Craigengillan. Original survey by J. Geikie. Ordovician revised by B. N. Peach and J. Horne. Post-Ordovician revised by J. B. Simpson ; E. B. Bailey, District Geologist.

Fifeshire, 27 S.E.—Strathore. Original survey by H. H. Howell. Revised by J. Knox ; C. H. Dinham, District Geologist.

Fifeshire, 35 N.W.—Lochgelly (E. part). Original survey by H. H. Howell. Revised by J. K. Allan ; C. H. Dinham, District Geologist.

Fifeshire, 37 S.E.—Culross. Original survey by B. N. Peach. Revised by D. Haldane ; C. H. Dinham, District Geologist.

Fifeshire, 38 S.W.—Torry Bay. Original survey by B. N. Peach and A. Geikie. Part revised by H. B. Maufe. Revised by D. Haldane ; C. H. Dinham, District Geologist.

Fifeshire and Kinross-shire, 26 S.W.—Blairadam. Original survey by A. Geikie and B. N. Peach. Revised by J. K. Allan ; C. H. Dinham, District Geologist.

Fifeshire and Kinross-shire, 33 N.W.—Saline (N. of). Original survey by A. Geikie and J. Geikie. Revised by D. Haldane ; C. H. Dinham, District Geologist.

Fifeshire and Kinross-shire, 34 N.W.—Blairenbathie. Original survey by A. Geikie. Revised by J. K. Allan, D. Haldane and C. H. Dinham, District Geologist.

Kinross-shire, 24 S.E.—Dollar. Original survey by B. N. Peach. Revised by D. Haldane ; M. Macgregor, District Geologist.

Lanarkshire, 7 N.W.—Garnkirk. Original survey by J. Geikie. Revised by W. B. Wright and L. W. Hinxman, District Geologist ; C. T. Clough, District Geologist. Reprinted on new topography.

Lanarkshire, 38 N.W.—Poniel. Original survey by B. N. Peach. Revised by G. Ross ; M. Macgregor, District Geologist.

Lanarkshire, 38 N.E.—Ponfeigh. Original survey by B. N. Peach. Revised by H. H. Read and J. Phemister ; M. Macgregor, District Geologist.

Stirlingshire, (18a S.W. and 25 N.W.).—Bothkennar Foreshore. Original survey by B. N. Peach. Revised by C. B. Crampton, D. Haldane and C. H. Dinham, District Geologist.

Manuscript copies of the following maps on the scale of six inches to one mile were deposited in the Library for public reference. They are not to be published. The English maps are deposited in the head office in London. These manuscript copies of unpublished

maps may be examined in the Library of the Geological Survey on week-days from 10 a.m. to 5 p.m. Copies of them may be obtained at the cost of drawing which will be quoted on application to the Superintendent of Maps. Photographs of these maps will also be supplied, on the scale of 3 inches to one mile approximately, at the cost of 2*s.* 6*d.* to 3*s.* 6*d.* per quarter-sheet.

The Scottish manuscript copies which are deposited in the office at 19, Grange Terrace, Edinburgh may on application be forwarded to the London office for consultation.

Library Copies of English Manuscript Standard Maps deposited for reference

Dorset, 15 N.W., N.E., S.W., S.E.; 16 N.W., S.W.; 22 S.W., S.E.; 23 S.W., S.E; 24 S.W., S.E.; 25 N.E., S.W., S.E.; 26 N.W., N.E., S.W., S.E.; 30 S.E.; 31 N.W., N.E., S.W., S.E.; 32 N.W., N.E., S.W., S.E.; 33 N.W., N.E., S.W., S.E.; 34 N.W., N.E., S.W., S.E.; 35 N.W., N.E., S.W., S.E.; 38 S.E.; 39 S.W., S.E.; 40 N.W., N.E., S.W., S.E.; 41 N.W., N.E., S.W., S.E.; 42 N.W., N.E., S.W., S.E.; 43 N.W., N.E., S.W., S.E.; 44 N.W., N.E., S.W.; 45 (N.E. and S.E.); 46 N.W., (S.W. and 52 N.W.), S.E.; 47 N.W., N.E., S.W., S.E.; 48 N.W., N.E., S.W., S.E.; 49 N.W., N.E., S.W., S.E.; 50 N.W., N.E., S.W., S.E.; 51 (N.W. and N.E.); 52 N.E., S.E.; 53 N.W., N.E., S.W., S.E.; 54 N.W., (N.E. and S.E.); 55 N.W., N.E., S.W., S.E.; 56 N.W., N.E., S.W., S.E.; 57 N.W., S.W.; 58 N.W., N.E., S.E.; 59 N.W., N.E.; 60 (N.W. and N.E.).

Hampshire, 8 N.W. (Berks., 42a N.W.), N.E., S.W., S.E.; 9 N.W., N.E., S.W. S.E.; 10 N.W., N.E., S.W., S.E.; 11 N.W., N.E., S.W., S.E.; 12 N.W., S.W.; 16 N.W., N.E., S.W., S.E.; 17 N.W., N.E., S.W., S.E.; 18 N.W., N.E., S.W., S.E.; 19 N.W., N.E., S.W., S.,E.; 20 N.W., S.W.; 26 N.W., N.E., S.W., S.E.; 27 N.W., N.E. S.W., S.E.; 28 N.W., S.W.; 89 N.W., N.E., S.W., S.E.; 90 N.W,. N.E., S.W., S.E.; 91 N.W., N.E., S.W., S.E.; 93 N.W., N.E., S.W., S.E.; 94 N.W., N.E., S.W., S.E.; 95 N.W., N.E., S.W., S.E.; 96 N.W., N.E., S.W., S.E.; 97 N.W., N.E., S.E.; 98 N.W., N.E., S.W., S.E.; 99 N.W., S.W.; 100 N.W., N.E.

Lancashire, 103 S.W., S.E.; 109 N.E. (part); 110 N.W. (part), N.E. (part); 111 N.W. (part), N.E. (part).

Wiltshire, 40 N.W.

Yorkshire, 271 S.W.

Scottish Manuscript Maps deposited for reference

Ayrshire, 44 S.E.; 45 S.W., S.E.; 47 N.E.; 51 N.W.

Lanarkshire, 27 N.W., N.E., S.W., S.E.; 39 S.E.

Peeblesshire, 11 N.W., N.E., S.W., S.E.

List of Maps in the press at the close of 1930

English Maps in the press

¼ inch to 1 mile :—

Sheet 15.—Birmingham, Northampton, Gloucester, Oxford, Worcester. (*Revised*).

Sheet 16.—Cambridge, Colchester, Ipswich. (*Revised*).

1 inch to 1 mile :—

Sheet 3.—Ford (*Solid and Drift Editions*).

Sheet 5.—Cheviot (*Drift Edition*).

Sheet 18.—Brampton (*Drift Edition*).

Sheet 86.—Glossop.
Sheet 152.—Shrewsbury (*Drift Edition*).
Sheet 232.—Abergavenny.

6 inches to 1 mile (coalfield maps) :—

Brecknockshire, 43 N.E., S.E. ; 44 N.W., N.E., S.W., S.E. ; 49 N.E.
Cumberland, 35 S.E. ; 36 N.W.
Glamorganshire, 9 N.E. ; 10 N.W.
Lancashire, 97 N.E.
Northumberland, N.44 N.W., S.W. ; N.51 N.W., S.W., S.E. ; N.52 N.W. ; N.60 N.W., N.E. ; N.61 S.W., S.E. ; N.69 N.W. ; N.70 N.E.
Shropshire, 36 S.W. ; 43 N.W., S.W. ; 51 N.W., N.E.
Yorkshire, 260 S.E.

Scottish Maps in the press

½ inch to 1 mile :—

Sheet 3.—Orkney Islands.
Sheet 14.—Stirlingshire, Dumbartonshire, Renfrewshire, with parts of Lanarkshire (North and Central), Ayrshire (North), Buteshire (North), and Argyllshire (South-East).

1 inch to 1 mile :—

Sheet 24.—Peebles.
Sheet 108.—Altnaharra.
Sheet 109.—Achentoul.
Sheet 117.—Hoy, Orkney Islands.
Sheet 118.—Copinsay, Orkney Islands.
Sheet 119.—Kirkwall, Orkney Islands.
Sheet 120.—Stronsay, Orkney Islands.
Sheet 121.—Westray, Orkney Islands.
Sheet 122.—Sanday, Orkney Islands.
Glasgow District Map.—*Solid and Drift Editions.*

6 inches to 1 mile (coalfield maps) :—

Ayrshire, 30 S.E. ; 36 N.W. ; 41 N.E. ; 42 N.W., S.W.
Fifeshire, 28 S.W. ; 33 N.E., S.W., S.E. ; 34 S.W. ; 36 N.W. ; 38 N.W., N.E., S.E.
Fifeshire and Kinross-shire, 25 S.W., S.E. ; 26 S.E.
Lanarkshire, 18 S.E. ; 37 S.E. ; 38 S.W.

II.—Vertical Sections of Strata

English Vertical Sections in the press at the close of 1930

Sheet 93.—Sections of Shafts in the Coal Measures of the Abergavenny District (Sheet No. 232) of the South Wales Coalfield, being supplementary to Vertical Sections, Sheet 81.
Sheet 94.—Sections of Shafts and Borings in the Southern Part of the South Staffordshire Coalfield.
Sheet 95.—Sections of Shafts and Borings in the Southern Part of the West Cumberland Coalfield.

Scottish Vertical Sections in the press at the close of 1930

Sheet 16.—Illustrative of the Ayrshire Coalfields. Area III (Prestwick, Mauchline, Cumnock and Muirkirk).
Sheet 18.—Illustrative of the Clackmannanshire Coalfield, including part of West Fife.
Sheet 19.—Illustrative of the Fife Coalfields. Area I (Dunfermline and West Fife).

III.—Memoirs

English Memoirs published in 1930

Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the year 1929 :—

Part I.—With Report of the Geological Survey Board and Report of the Director. 100 pp., 7 text-figures. 1930. Price 2*s. net.*

Part II.—80 pp., 3 plates, 22 text-figures. 1930. Price 2*s. net.*

Part III.—89 pp., 8 plates, 11 text-figures. 1930. Price 2*s.* 6*d. net.*

Wells and Springs of Gloucestershire. By L. Richardson, F.R.S.E., F.G.S. 292 pp., 1 plate, 8 text-figures. 1930. Price 5*s. net.*

Wells and Springs of Worcestershire. By L. Richardson, F.R.S.E., F.G.S., with contributions by Cecil Cooke Duncan, F.I.C., F.C.S., and B. Brotherton, F.R.G.S. 219 pp., 1 plate, 3 text-figures. 1930. Price 4*s. net.*

The Geology of the Alnwick District. (Explanation of one-inch Sheet 6 : England and Wales). By R. G. Carruthers, G. A. Burnett, B.Sc., and W. Anderson, M.Sc. ; with contributions by C. H. Dinham, B.A., and the late J. Maden, M.Sc. 138 pp., 4 plates, 4 text-figures. 1930. Price 3*s. net.*

The Geology of the Maryport District. (Explanation of one-inch Sheet 22 : England and Wales). By T. Eastwood, A.R.C.Sc. 137 pp., 3 plates, 19 text-figures. 1930. Price 3*s. net.*

The Geology of the Country around Huddersfield and Halifax. (Explanation of one-inch Sheet 77 : England and Wales). By D. A. Wray, Ph.D., M.Sc., Senior Geologist, J. V. Stephens, B.Sc., B.Eng., W. N. Edwards, M.A., and C. E. N. Bromehead, B.A., District Geologist. 221 pp., 5 plates, 13 text-figures. 1930. Price 4*s.* 6*d. net.*

Scottish Memoirs published in 1930

Summary of Progress.—See above.

The Geology of North Ayrshire. (Explanation of one-inch Sheet 22 : Scotland). *Second Edition.* By J. E. Richey, M.C., B.A., E. M. Anderson, M.A., B.Sc., and A. G. MacGregor, M.C., B.Sc. ; with contributions from E. B. Bailey, M.C., B.A., G.V. Wilson, B.Sc., G. A. Burnett, B.Sc., and V. A. Eyles, B.Sc. Palaeontological Chapters by the late G. W. Lee, D.Sc., and R. Crookall, Ph.D., and an account of the Soils and Agriculture by the late R. A. Berry, Ph.D., F.I.C., E. M. Melville, M.A., B.Sc., A.I.C., and C. Louden, B.Sc., A.I.C., of the West of Scotland Agricultural College. 417 pp., 10 plates, 42 text-figures. 1930. Price 10*s. net.*

The Geology of Ardnamurchan, North-west Mull and Coll. (Explanation of one-inch Sheet 51 and part of Sheet 52 : Scotland). By J. E. Richey, M.C., B.A., and H. H. Thomas, M.A., Sc.D., F.R.S. ; with contributions by E. B. Bailey, M.C., M.A., F.R.S., J. B. Simpson, B.Sc., V. A. Eyles, B.Sc., and the late G. W. Lee, D.Sc., with Chemical Analyses by E. G. Radley, F.C.S., and B. E. Dixon, M.Sc., A.I.C. 393 pp., 8 plates, 54 text-figures. 1930. Price 10*s. net.*

The Economic Geology of the Ayrshire Coalfields. Area III (Ayr, Prestwick, Mauchline, Cumnock and Muirkirk). By V. A. Eyles, B.Sc., J. B. Simpson, B.Sc., and A. G. MacGregor, M.C., B.Sc. 175 pp., 4 plates, 12 text-figures. 1930. Price 4*s. net.*

English Memoirs in the press at the close of 1930

Wells and Springs of Leicestershire.

The Geology of Manchester and the South-East Lancashire Coalfield. (Explanation of one-inch Sheet 85 : England and Wales).

Scottish Memoirs in the press at the close of 1930

The Economic Geology of the Fife Coalfields. Area I (Dunfermline and West Fife including Valleyfield, Blairhall, Oakley, Saline, Halbeath, Lassodie and Blairenbathie).

The Geology of Central Sutherland. (Explanation of one-inch Sheets 108 and 109 : Scotland).

Geophysical Work

During the past year a considerable amount of work has been carried out with the Schmidt vertical magnetometer and with the Eötvös Torsion Balance. The interesting results obtained by Mr. Hallimond over the Swynnerton Dyke[1] showed that the vertical magnetometer was a valuable aid in tracing the concealed outcrops of basic igneous rocks and a second investigation of a similar problem was undertaken by Drs. McLintock and Phemister in Scotland. The Lornty Dyke, which outcrops at various places about one mile to the north and north-west of Blairgowrie, Perthshire, where it has been quarried for road-metal, was selected, and five traverses in all were made across its concealed outcrop. The rock is a tholeiite of Brunton type consisting of labradorite and augite in approximately equal proportions with varying amounts of olivine which is always serpentinized. Small patches of microcrystalline mesostasis consisting of felspar and pyroxene are scattered uniformly through the rock, which contains about 5 per cent. by volume of iron ore as crystals, grains and skeletal growths. The dyke is 30 ft. in width, dips steeply towards the north and strikes practically magnetic east and west.

In all 139 stations were observed in the course of slightly over three days' field work. The observed values were subsequently corrected for temperature and daily variation, the latter correction being kindly supplied by Major A. H. R. Goldie of the Meteorological Office, Edinburgh, from curves of vertical force recorded at Eskdalemuir Observatory. Two of the traverses made near the visible outcrop but at localities one mile apart, show anomalies of 630 γ and yield curves which differ in an interesting way from that of the Swynnerton Dyke. They show a maximum from which the values fall away gradually to the north, i.e., in the direction of dip of the dyke, but to the south the values decrease rapidly to a minimum and then rise again away from the dyke. This, of course, demonstrates that the simple assumption made in the case of the Swynnerton Dyke, namely, that the top of the dyke consists of elemental south poles uniformly distributed, is not always applicable. If it were, no minimum turning value is to be expected in the curves, and no fall

[1] *Mining Magazine*, July, 1929; 'Summary of Progress' for 1929, Part iii (*Mem. Geol. Surv.*), 1930, p. 44.

below normal vertical force can occur, both of which are present in the case of the Lornty Dyke. A study of the curves suggests that the dyke is magnetised with a south polarity on its hanging (northern) wall and a north polarity on its foot wall but, since the dip of the dyke practically coincides with the earth's magnetic field, it is difficult to conceive such a distribution of polarity resulting from induction. The fact that the dykes in question (Swynnerton and Lornty) are, in the one case parallel to the magnetic meridian and in the other case perpendicular to it, may be of importance.

With a view to improving the equipment for carrying out gravitational surveys it was decided to purchase an up-to-date type of torsion balance. Considerable improvement in the design of these instruments has been effected in recent years and after due consideration it was finally decided to acquire an Eötvös-Süss small balance. The advantages claimed for this instrument are its small size, ease of manipulation—it is visually read—quickness of working, and the fact that it can be operated in the field during the hours of daylight. Delivery of this instrument was secured in March, when it was set up in the crypt of the Museum and found to be in excellent working order. Owing to pressure of other duties the officers in charge of gravitational work did not proceed to the field till September when a survey was undertaken at Thrussington, Leicestershire, over the region of magnetic anomaly described by Mr. Hallimond in last year's Summary of Progress (Part II). The relation between gravitational and magnetic anomalies is by no means clearly defined and the survey with the torsion balance was carried out to see firstly if any gravitational anomaly existed on the site of the magnetic one and secondly if the gravitational results yielded the same geological interpretation as that put forward by Mr. Hallimond. In all 63 stations were determined by visual observation. It was found that the balance behaved admirably during the day, when it yielded values differing but slightly from those given by check observations at night. Further, as a result of repeated trial, it was found that, except under abnormal conditions of temperature variation, four observations, i.e., one observation each in three azimuths with a repeat check in the first azimuth, were sufficient to determine the values of gradient and curvature with sufficient accuracy. The terrain over which the survey was made is hilly in places and it was necessary to prepare a 5-ft. contour map in order to compute topographical corrections. This was duly completed and the final residual values of gradient and curvature plotted for each station. The results show unmistakably that the area is characterised by a marked gravitational anomaly amounting to .0026 dyne over a distance of a little less than one mile.

The gravitational anomaly covers a considerably wider area than the magnetic one. Its crest lies about 1/3 mile W.N.W. of the line of maximum vertical magnetic force, whilst the directions of the two crests are inclined to one another at an angle of 20°. The gradients of gravity are generally remarkably constant in direction

and indicate as their cause the rising of a mass of heavy rock towards the north-west.

There are no exposures of rock in the neighbourhood and there is little information from boring. The superficial deposits are chalky boulder-clay with patches of sand underlain by Keuper Marl, but the nature of the rocks underneath the Keuper Marl is unknown. The gravitational results, however, indicate that they must have a specific gravity at least .3 higher than the Keuper Marl, which seems to indicate that they belong to the Charnian Series.

The evidence points to the conclusion that a mass of older and heavier rock, probably belonging to the Charnian, rises at a slope of approximately 7° towards the north-west underneath the Keuper Marl.

The northern boundary of the area surveyed is crossed by the Sileby Fault, which brings down the Lias on the north against the Keuper Marl on the south. The opportunity was taken to run a short traverse across this structure, the existence of which was very clearly shown by the variation in the gradients.

Magnetic surveys have been made by Mr. Hallimond at Portobello, at Groby, Leicestershire, and at Pipewell, Northants. At Portobello, a moderate magnetic anomaly was shown to terminate against the line of the Pentland Fault. Exceptionally steady conditions permitted a close-contoured mapping of the Groby area, which demonstrated the extension of magnetic rock below the Keuper Marl and also below the Charnian grits. The magnetic strike is generally in a north-westerly direction. The test at Pipewell was made in order to see how great a disturbance would be caused by the Northampton ironstone. Two traverses across known faults indicated that the " brown stone " at outcrop gives only low disturbances not exceeding 20 γ.

Soil Mapping

ENGLAND AND WALES.—This year the Soil Survey Conference, arranged by the Development Commission and the Ministry of Agriculture and Fisheries, was held at Bangor, North Wales, for the study of the soils on the University College Farm at Aber.

The area around Aber has not been re-surveyed since the original survey, on the one-inch scale, published on Old Series geological map No. 78, in 1852. Since the only cultivated portion of the farm is heavily covered by Drift deposits, and no drift map is in existence, it was necessary for Mr. H. G. Dines to make a preliminary examination of the ground, prior to the meeting of the Conference.

The farm is situated on faulted and folded Upper Cambrian and Lower Ordovician rocks. The slopes of the mountain consist of Llandeilo slates. In his examination of the superficial deposits Mr. Dines found that the belt of low ground running along the shore is covered with red Boulder Clay of northern origin, possibly composed largely of Triassic material. This appears to rise inland to about 150 ft. O.D., but its landward edge is masked by a downwash

of shaly material from the mountain side. This latter is variable in thickness but it appears to reach a maximum of about 6 ft. just below the 300-ft. contour. The seaward margin of the Boulder Clay has been eroded by marine action and a wave-cut terrace has been formed, which terminates at a sharp feature immediately below and parallel to the 100-ft. contour. The surface of the terrace is covered here and there with marine sand and gravel.

The Soil Series on the Aber Farm have been classified in the following manner :—

Bangor Suite from Igneous and Pyroclastic rocks, and hard Grits.

Normal Sedentary	Bangor Series.
Drift with free drainage	Ebenezer ,,
Drift with impeded drainage	Sion ,,

Anglesey Suite from Pre-Cambrian metamorphic rocks.

Normal Sedentary	Anglesey Series.
Drift with free drainage	Gaerwen ,,
Drift with impeded drainage	Gesail ,,

Powys Suite from older Palaeozoic Sedimentary rocks (Shales, etc.).

Normal Sedentary	Powys Series.
Drift with free drainage	Penrhyn ,,
Drift with impeded drainage	Cegin ,,

Local Hillwash over Triassic Boulder Clay ... Aber Series.

Sir Thomas H. Middleton, who attended the Conference, writes as follows :—

" I was present at a Soil Survey Field Meeting at Bangor on the 29th-30th ult. This meeting was attended by most of the Advisory Chemists interested in soil surveys, by two members of the Geological Survey (Mr. H. G. Dines and Mr. J. B. Simpson) and by several others ; it lasted from the 28th April until May 2nd and was the fifth of a series of Annual Meetings. At all these meetings the procedure is similar, there are discussions on subjects of interest to soil surveyors, but the main purpose is to examine, map, and compare the results reached by small groups of surveyors into which those members attending the meetings are divided up, with the object of gaining experience of survey methods and ascertaining the degree of uniformity that can be reached by separate groups working on a common method.

" It was agreed by those who have taken part in these field meetings that since they were instituted much progress has been made with soil studies. Sharp differences of opinion formerly existed, now there is general agreement as to (1) the methods that should be followed in the field and (2) the principles on which maps should be constructed. A definite stage in the subject of soil surveying having thus been reached, the progress so far made may be outlined.

" Soil surveys of certain tracts of country, e.g., of Norfolk, were made in the middle of last Century, and some former members of the staff of the Geological Survey took a personal interest in soils and wrote papers on the subject ; but the first extensive survey in this country was that begun at Wye College in 1899 of which the results were published by Hall and Russell in 1911. This was essentially a description of the agricultural practices associated with the geological formations of the S.E. Counties, together with mechanical and chemical analyses of typical soils. Somewhat similar surveys were begun at Cambridge about 1905, and have been continued intermittently until recently. A report on these Eastern Counties soils is still awaited ; but it is understood that it will shortly be available.

" As soon as the Development Fund was available applications for special research grants for soil surveys were received, and surveys of different types were undertaken. The Midland College and Holmes Chapel, for example, carried out preliminary surveys, following the methods of Hall and Russell ; in the Aberystwyth area Professor O. T. Jones conducted surveys based mainly on local geology, and similar work was done by Mr. Monie in the South West of Scotland.

" About ten years ago Professor Robinson of Bangor and Dr. Ogg of Edinburgh, who were specially interested in soils, began to study Russian and American methods of soil surveying and, largely by their efforts, the interest of other soil workers was enlisted. It was clear from the experience gained in these countries that improvement was necessary in our British methods, and that the field methods of the geologist must be linked to the laboratory studies of chemists.

" In 1924 a Conference between members of the Geological Survey and soils investigators was arranged, and joint action was agreed upon. The Geological Survey put at the disposal of agricultural workers all the information and experience available in the Survey, and deputed skilled field geologists to accompany soil surveyors at annual field meetings. The purpose of these meetings was to discover how soils should be examined, classed, and mapped, so as to yield the greatest possible amount of useful information. There was at first no agreement as to how a survey should be made, so that it was decided to adopt tentative methods and to try them out in the field. Provisional instructions for surveyors were issued and these were followed out in different districts. While this work was going on, we were fortunate in getting aid from experienced soil workers in other countries ; partly through conferences arranged by the International Society of Soil Science, but chiefly through the visits to this country of foreign soil workers. Two senior members of the staff engaged on the American soil survey, Messrs. Veatch and Linwood L. Lee, spent periods in Great Britain, worked with our surveyors and gave them much help ; and a Russian, Professor Turin, has also given valuable assistance.

"The result is that, as stated above, there is now substantial agreement as to how soil surveying should proceed in future, and while details have still to be settled and experience gained, we can look forward to progress.

"It has been agreed that, following American practice, soils should be classified into Series, depending on parent material, mode of formation and some half dozen features that can be recognised in the field; and that these Series should be further subdivided into "types," depending on texture; primarily, but not wholly, on the texture of the surface soil.

"The characters which should constitute any one Series and mark it off from a second have been laid down on paper, and Series can be distinguished more or less accurately in the field by perhaps a dozen workers. But the characters determining a "Series" are not of a kind that can be measured with exactitude, and the actual classification in the field must still largely be a matter of opinion. It is therefore necessary to standardise the work, so that the observations of different surveyors may be comparable. For this reason it is agreed that the next step necessary is to examine and class the chief soil Series in all the districts in which surveyors are at work, and it is proposed by the Soil Survey Committee that a Correlation Committee should be set up, consisting of say four of the most experienced field workers together with a member of the Geological Survey."

The Soils Correlation Committee, proposed by the Bangor Conference, was set up later in the year by the Ministry of Agriculture and Fisheries in conjunction with the Department of Agriculture for Scotland and constituted as follows:—Mr. W. Morley Davies, Professor J. A. Hanley, Dr. W. G. Ogg, Professor G. W. Robinson and Mr. T. Wallace.

The first meeting of the Committee met on August 29th and was attended by Mr. J. Allen Howe on behalf of the Geological Survey. Arrangements were initiated for the Committee, with an officer of the Geological Survey, to visit next year each area in which work is proceeding, to examine a selected group of soils in company with the local surveyor and to classify them.

SCOTLAND.—Field work was continued in South Ayrshire (one-inch Sheet 14) by the staff of the Chemistry Department of the West of Scotland Agricultural College under Professor D. N. McArthur. Professor McArthur reports that the field sampling and mapping of the area was completed during the summer months by Dr. C. L. Whittles and Mr. I. C. Jack. Sampling was less frequent than in the previous year to enable the field work to be completed. A considerable portion of the area surveyed this year was high land used for sheep grazing, and a detailed examination was deemed not to be necessary. 1600 samples were collected and 800 of these were partially examined in the laboratories of Ayr Academy during the summer. This was only possible by the co-

operation of the Ayrshire Education Committee and the voluntary assistance of 14 senior pupils of Ayr Academy. The results, so obtained, were invaluable in checking the observations and classification in the field. The mechanical analyses of the remaining samples were completed in the chemical laboratories of the West of Scotland Agricultural College, Glasgow, with assistance from four post-graduate workers.

All the soil samples collected have now been classified and the classification checked by analysis. The final mapping on the scale of six inches to the mile has been completed and is now ready for reduction to the one-inch scale.

A permanent collection, showing the natural colour of each of the 3050 soil samples, has been made : while about one half of the samples showing the colour of the soil after oxidation have been mounted. The collection will be completed soon.

The examination of the moisture content and loss on ignition of all samples was finished. The lime requirement and the pH values, in water and salt solution, have been obtained for about 1400 samples. The chemical examination of soils typical of each texture class is now in progress.

The results of this survey will be published on the one-inch scale on a map corresponding to that issued for North Ayrshire in 1929, to accompany the solid and drift editions of one-inch Sheet 14, Scotland (Dalmellington), which are now in preparation.

Inspection of Bores and Shafts

ENGLAND AND WALES.—In England and Wales during 1930 only eight new boreholes and shaft sinkings were notified. Mr. Templeman has visited four shaft sinkings and twenty-five borings ; of these, two were for coal, nineteen for iron ore, one for lead and spar, two for limestone and five for water.

Regular inspections have also been made by other members of the staff in their respective districts, the most important being the new shaft at Beighton Colliery, Sheffield, which has been kept under close observation by Dr. Wray, and certain developments in the Kent coalfield.

We are indebted to Mr. F. Walter Hodson, M.Inst.C.E., for facilities for the examination of the cores of a boring at the Brickworks, near Hathern Station, north-east of Charnwood Forest. As a result of his examination of the cores, Mr. Templeman suggests that the ' Forest Rock ' (Pre-Cambrian), reached at 402 ft. in the earlier Hathern borehole,[1] only 20 ft. distant from the new borehole, is actually part of the Permo-Triassic Breccia, now seen to overlie bituminous shales of the upper part of the Eumorphoceras Zone of the Millstone Grit Series. The Breccia is unconformably overlain by diminished deposits of Bunter Pebble Beds, followed by Keuper Sandstone and normal Keuper Marl.

[1] ' Geology of the Country between Derby . . . and Loughborough ' (*Mem. Geol. Surv.*), 1905, p. 55.

With the kind assistance of Mr. H. S. Skinner of the West Gloucestershire Water Company, a fine series of Jurassic rocks (Forest Marble to Cotteswold Sands) has been collected by Mr. Templeman from borings at Shipton Moyne. The Upper Lias Cephalopoda Bed is here only 6 to 10 inches thick and contains Grammoceratan ammonites of the Striatulum-thouarsense horizon, similar to those from the upper part of the Cephalopoda Bed of the Tetbury borings.

During the year 942 specimens have been registered, 1628 specimens have been transferred to the boring series from other departments, and a large amount of new material has been under investigation. Specimens from borings are also accumulating temporarily in the York and Manchester offices. Work on the checking and filing of old records has been continued.

SCOTLAND.—Under Section 23 of the Mining Industry Act (1926) 45 notifications were received in the Scottish office during the year. Thirteen of these included two or more borings.

Visits to borings, mines and shaft sinkings have been made by Mr. W. Manson, but in some instances the geologists concerned in mapping the ground have also inspected the cores of bores. The exact sites of all bores and shafts have been inserted on the six-inch working maps. Copies of the journals have been checked by examination of the cores at borings, and of specimens of the strata passed through at mines and shafts. In nearly all cases records have been prepared in graphic form to allow of ready comparison with the sections of other bores and shafts preserved in the files of the department. Mr. Manson has also rendered much assistance to mining engineers regarding the interpretation of sections of strata proved by some of the borings.

Suites of fossils and specimens of rock have been selected from borings and shafts for inclusion in the Survey collections. A number of examples of non-marine lamellibranchs have been obtained from a new mine in the Productive Coal Measures at Dalmellington, Ayrshire, and these shells have served to show the presence in this coalfield of the Modiolaris Zone of the zonal succession established by Davies and Trueman in South Wales and Staffordshire. The specimens from the mine at Dalmellington have been obtained from beds of blaes associated with the Chalmerston, Minnivey, Sloanstone and Pennyvennie Two Foot Three coals. The following fossils were collected :—*Anthracomya* cf. *cymbula* Wright, *A. modiolaris* (J. de C. Sow.), *Carbonicola aquilina* (J. de C. Sow.), *C. concinna* Wright, *C.* cf. *nucularis* Hind, *C. phrygiana* Wright, *C.* cf. *turgida* (Brown), *C.* cf. *venusta* D. and T., *Naiadites sp.*

Several specimens of well-preserved goniatites have been obtained from the following stratigraphical levels proved by borings in Stirlingshire :—

(1) beds near the base of the Millstone Grit,
(2) bed of blaes associated with Plean No. 3 Limestone,

(3) calcareous shales underlying the Calmy Limestone and overlying the well-known index bed with *Edmondia punctatella* (Jones).

The specimens have been submitted to Mr. W. S. Bisat, F.G.S., who has kindly identified them as late forms or mutations of *Anthracoceras glabrum* Bisat. On this evidence, therefore, the strata between the Calmy Limestone and the beds immediately above the Castlecary Limestone may be regarded as occupying a position near the top of Zone E of Mr. Bisat's classification. A similar conclusion about the horizon of these rocks was reached by Messrs. Pringle and Jackson[1] who based their opinion on the range of *Tylonautilus nodiferus* (Armstrong).

Building Stones Research

The co-operative study of the British building stones, for which arrangements were made between the Geological Survey and the Building Research Station at the close of 1929, was begun this year, and the first stage of the work has been carried out.

Two groups of building stones have been examined, (1) the Portlandian rocks of the Isle of Portland, the Isle of Purbeck, Chilmark, Tisbury, Poxwell, Upwey and Portisham; (2) the Magnesian Limestone outcrop from South Nottinghamshire to Durham.

Field work in the first group was undertaken by Mr. F. H. Edmunds, and in the second group by Dr. G. H. Mitchell. In both cases a thorough examination was made of all quarries, and reports have been submitted dealing with the geological features, local peculiarities, methods of working and the utilization of the material. A large number of samples was collected and despatched to the Building Research Station for preliminary examination.

Subsequently, both the Geological Survey officers made rapid traverses of their areas in conjunction with Mr. R. J. Schaffer of the Building Research Station, for the examination of selected quarries and investigation of the state of weathering in many of the old buildings in which the stones have been employed.

During the progress of the field work subjects suitable for photography were selected, which were visited later by Mr. J. Rhodes, who secured in the Portland area 81 negatives and in the Magnesian Limestone area 266. Prints have been supplied to the Building Research Station and have been included in the Survey collection.

In accordance with the scheme of operations, the specimens sent to the Building Research Station have been put under a restricted series of physical tests, and an excellent set of microsections has been prepared in duplicate, one set being transferred to the Survey for petrological examination; this includes 98 slides of the Portlandian rocks and 86 of the Magnesian Limestone.

The next stage in the investigation will be the collection of a series of cut and faced blocks from selected quarries for permanent

[1] Pringle, J. and J. W. Jackson, '*Tylonautilus nodiferus*: A Carboniferous Guide Fossil,' *The Naturalist*, 1928, p. 377.

exhibition in the Museum, and to these more important building stones an extended set of tests may be applied.

It may be remarked that the field observations, apart from their specific object, have been the means of bringing to the Survey office a good deal of generally useful information.

Conferences

At the Centenary celebrations of the Société Géologique de France, held in Paris in June, Sir John Flett and Dr. H. H. Thomas represented the Geological Survey of Great Britain and presented an address of congratulation.

The Sixth International Congress of Mining, Metallurgy and applied Geology was held in Liége in June and was attended by Dr. W. F. P. McLintock as Government delegate of the Geological Survey of Great Britain.

At the British Association Meeting at Bristol in September Dr. Crookall represented the Geological Survey of Great Britain. He also contributed a chapter to the Association's Handbook. An exhibition of Survey memoirs, maps and photographs was displayed in one of the rooms adjacent to the meetings of the Geological Section.

In August the Geologists' Association had a field excursion to St. Davids, and Mr. John Pringle served as one of the conductors of the excursion.

In September the Director attended the International Union of Geodesy and Geophysics in Stockholm as one of the British delegates.

In August the Geological Survey was represented at the Fifth International Botanical Congress which met in Cambridge by Dr. R. Crookall, palaeobotanist. A selection of plant fossils from the Survey's collection was exhibited at the Congress and attracted much attention from foreign visitors.

Staff Changes

In December Dr. H. H. Read was appointed Professor of Geology in the University of Liverpool and is to undertake his new duties in April, 1931. Dr. Read has served on the Scottish staff since 1914 and has been engaged on the survey of Highland metamorphic rocks, in which difficult sphere he has earned a brilliant reputation. He receives the congratulations of all his colleagues on his professorial appointment.

Mr. T. Eastwood has been promoted to District Geologist and has taken charge of the Cumbrian unit. Mr. H. G. Dines has been promoted to Senior Geologist.

Two vacancies were filled by appointments to the staff as geologists on probation—Mr. W. C. C. Rose on the 22nd September and Dr. T. N. George on the 1st October.

Collaboration

The following specialists have rendered valuable assistance to the Survey during the past year. Mr. Linsdall Richardson (water supply memoirs), Professor D. M. S. Watson (fossil fishes), Professor W. H. Lang (fossil plants), Professor A. E. Trueman (fossil freshwater lamellibranchs), Mr. W. S. Bisat (goniatites from the Carboniferous), Miss Gertrude Elles (graptolites), Mr. A. G. Davis (Cretaceous Microzoa), Professor H. L. Hawkins (Jurassic echinoids), Dr. Stanley Smith (Palaeozoic corals), Dr. E. S. Cobbold (Cambrian fossils); and Mr. W. D. Ware has given assistance in collecting fossil plants from the Coal Measures of the Merthyr Tydfil area.

Dr. W. G. Shannon has contributed a chapter to the Torquay memoir on the igneous rocks of that district.

Special mention should be made of the generous assistance given by Mr. E. O. Forster Brown in procuring access to information on the Kent coalfield and obtaining facilities for collecting specimens from shafts and mines.

Palaeontology

ENGLAND AND WALES.—The number of fossils added to the collections during the year was 12,719. Of these, 11,771 were entered in the registers of the Survey reference-collection, while in addition, the specimens obtained by presentation were 948 in number, 745 of which became registered. An important set of zonally collected fossils from the Chalk of Surrey was bequeathed by the late G. W. Young. These formed the basis of Young's paper, ' The Chalk Area of North-East Surrey,'[1] and are a valuable addition to the Survey reference-collection, as supplementing the fossils obtained during the course of the re-survey of that area. Mr. C. W. Osman presented a series of fossils from the Lower Chalk near Folkestone, collected by him with special reference to their exact position in the sequence. Further useful specimens for addition to the Survey set of zonally collected Carboniferous goniatites have been received from Dr. J. W. Jackson and Mr. E. W. J. Moore. These are of value in enriching the zonal collection of fossils now being selected for exhibition in the new museum.

The work of dealing with the large amount of palaeontological material which had to be investigated during the year was facilitated, as usual, by the co-operation of a number of specialists who are not members of the staff. Mr. C. P. Chatwin continued work on the fossils from the areas of Sheets 286 (Reigate) and 350 (Torquay), and while dealing with the palaeontology of the Reigate area he collated the collection of Chalk fossils bequeathed by the late G. W. Young. He completed his examination of the Devonian fossils in the Torquay Museum and revised a large number of determinations of specimens in the Survey collections from that district. In connexion with the same work he examined the collection of Devonian fossils in the Sedgwick Museum, Cambridge. Mr. Chatwin was

[1] *Proc. Geol. Assoc.*, vol. xix, 1905, p. 188.

also engaged in preliminary work connected with the selection of exhibits for the new museum, devoting his attention to illustrations of the geology of the Eastern Counties and the Hampshire Basin. Reference to work done by him on Pliocene fossils will be found below in the Report of the Palaeontological Department.

Dr. C. J. Stubblefield has been engaged during the year in identifying fossils from various areas now being surveyed in Yorkshire (Sheet 86, and parts of Sheets 87 and 99), South Wales (Sheet 231, with part of Sheet 230), Cumberland (Sheets 23 and 28), and Lancashire (Sheet 85). He has also drawn up many lists of fossils from these and other sheets that are in course of being surveyed. He has compiled a catalogue of at least 700 type-specimens of ammonites and brachiopods, figured or described by the late S. S. Buckman and now preserved in the collections of the Geological Survey and Museum.

Miss M. E. Odell has continued to make good progress with registration-work. She has given further attention to the specimens formerly in the cabinets of the Geological Society, but has devoted most time to other collections recently acquired.

An extensive programme of fossil-collecting was carried out by Mr. S. W. Hester and Mr. W. Dewar. Visits were made to the districts in Sheets 289 (Canterbury), 290 (Dover), 271 (Dartford), 286 (Reigate), 239 (Hertford), 166 (Church Stretton), 78 (Wakefield), 86 (Glossop), 87 (Barnsley), 75 (Preston), 76 (Rochdale), 84 (Wigan), 85 (Manchester), 97 (Runcorn), 23 (Cockermouth), and 24 (Penrith).

Mr. S. W. Morgan has been chiefly engaged in the development and registration of specimens, in giving assistance to a number of research workers, and in preparing for despatch numerous sets of fossils sent out on loan to collaborating specialists and to others engaged in preparing papers or monographs. The total loans amounted to 3,139 specimens.

Further work was done by Mr. D. W. Hepple during the first half of the year in cleaning and painting the interior of exhibition-cases in the Museum, cleaning the specimens and renovating the mountings.

Numerous enquiries have been dealt with during the year, and much assistance has been given to research workers and those engaged in special studies who have utilized specimens in the Museum.

SCOTLAND.—More than 1,400 specimens of fossils were collected during the year. These were obtained from the Old Red Sandstone of the Shetland Islands and from Carboniferous rocks occupying areas in Sheet 14 (Ayrshire), 23 (Lanark), 31, 32 (Linlithgow and Midlothian), 40 (Fife), 5-9 (Northumberland), and 21, 26 (Durham). In addition, Ordovician and Silurian fossils were collected from localities in Ayrshire, Peeblesshire and Kincardineshire. Many of the Carboniferous specimens were obtained from borings and sinkings in the Scottish coalfields and those of Northumberland and Durham. The collecting of the material was carried out by Messrs. Tait, Manson, Eckford and Fisher.

As in former years, fishes from the Old Red Sandstone have been submitted to Prof. D. M. S. Watson, F.R.S., for determination. The material from the other formations has been examined and named by Mr. J. Pringle, who has had occasional help from Prof. A. E. Trueman in the identification of species of Mollusca from the Coal Measures. A small but interesting set of ammonites from the Upper Lias of the Shiant Isles was also examined. These specimens have been presented by Dr. F. Walker to the Geological Survey and have been added to the reference-collections.

Further fossils have been transferred to the exhibited Survey Collection in the Royal Scottish Museum.

Special mention should be made of the magnificent collection of fossils presented to the Geological Survey by the late John Smith of Dalry, Ayrshire. Until the task of unpacking the boxes can be completed it will be impossible to estimate the number of specimens, but it will probably exceed 20,000. The fossils have been collected with great skill and discernment from many formations in Great Britain, but the greater part of the collection comes from the Carboniferous rocks of Scotland.

Palaeobotany

During the year, 222 fossil plants have been added to the collections by purchase and presentation. These were collected by Mr. W. D. Ware from the Coal Measures of the Merthyr area and include an important suite of specimens from the basement beds which suggest a correlation with the lowest Coal Measures of Scotland.

Loans of specimens were made from the Kidston Collection to Dr. R. Florin of Stockholm.

Apart from sinkings and boreholes, specimens of fossil plants have been identified from 18 one-inch Sheets.

Dr. Crookall attended the Fifth International Botanical Congress at Cambridge and the meeting of the British Association at Bristol, providing an exhibit in each case.

Owing to the exceptionally large number of foreign visitors attending these meetings, the Kidston Collection of fossil plants has been used by many palaeobotanists. These include Dr. Kawasaki (Japan), Dr. R. Florin and Professor T. G. Halle (Stockholm), Dr. S. Leclercq (Lille), Professor Julius Pia (Vienna), Dr. H. C. Sze (Berlin) and Dr. A. Renier (Brussels), as well as British workers.

Five cases have been added to the coal exhibit.

Mr. E. G. Radley has completed making prints of the 4,000 negatives in the Kidston Bequest and has prepared card catalogues of the Kidston Collection (7,000 fossils) and of specimens in the palaeobotanical collections. He has made 24 half-plate and 40 quarter-plate negatives and printed 26 enlargements, 55 whole plates, 238 half-plates, 8 five-by-four plates and 320 quarter-plates The number of prints mounted was 223.

Petrography

The Petrographical Department has dealt, as usual, with a great number of inquiries from the general public and Government Departments. It has been referred to in many instances by the Mines Department and the General Council of the Trades Union Congress on the question of rocks which do or do not come within the scope of the Silicosis Schemes of 1928 and 1930. All specimens of stone tested by the Road Board have been named and described. The department has undertaken to examine, register and store for reference all specimens and their corresponding sections collected by the Survey on behalf of the Building Research Station; and this work, as far as the Portland Stone Industry and the Magnesian Limestone are concerned, has made some progress. Numerous enquiries relating to objects of antiquarian and archaeological interest have been dealt with.

The Director has continued his investigation of the igneous rocks of the Orkney and Shetland Islands and has completed a detailed study of a teschenite sill revealed in the Saline No. 1 Boring. He has also continued his revision of the petrology of the Land's End district. Miss Guppy, with assistance from the Petrographer, has compiled a complete tabulated list of all the chemical analyses carried out by the Survey of igneous and metamorphic rocks and minerals, to the total of 606, and the work is ready for press. The memoir on the Tertiary Igneous Rocks of Ardnamurchan was completed by Mr. Richey and the Petrographer and published in October, 1930.

The petrography of the Wrekin and adjoining areas of Shropshire (Sheet 152) has been largely carried out by Messrs. Pocock and Whitehead with assistance from the Petrographer. That of a small portion of the Cheviot region (Sheet 6) has been published and that of the major part of the Cheviots (Sheets 3 and 5) including the granite, andesitic lavas and dykes, has been completed.

Dr. Read has completed his account of the petrology of that part of Sutherlandshire comprised by Sheets 108 and 109, and the petrology of Sheet 14 (Ayr) and Sheet 23 (Hamilton) has been continued by Messrs. Phemister, MacGregor and Kennedy.

The detailed mapping of Carrock Fell and the adjoining region of the English Lake District has resulted in the collection of much interesting petrographical material which will be dealt with in due course.

The number of sliced rock-specimens and corresponding sections registered in the collections and housed for reference in the Petrographical Department in London is as follows:—

English and Welsh	15,294
Scottish	27,847
Irish	451
Foreign	2,914
Total	46,506

This represents an aggregate increase of 994 in the registered sliced specimens during the past year. Of the corresponding sections 101 have been presented and the remaining 893 have been prepared in the London and Scottish offices.

The sliced collections have been thoroughly overhauled and many slides which had suffered damage in the post or from other causes have either been remade or repaired to the number of 241.

Mr. T. C. Hall has presented a large series of specimens and corresponding sections from the igneous and metamorphic rocks of the Korea. These are awaiting further details as to localities, but in due course will be registered and incorporated in the foreign sliced collections.

Photography

Mr. Rhodes has been employed in the field in taking 347 geological photographs and views to illustrate the Portland Stone Industry and that connected with the quarrying of the Magnesian Limestone. He has also taken a series of 138 in the Orkney Islands, and 48 in the Saffron Walden and Reigate districts of England. He has prepared a number of photomicrographs and enlargements.

The number of registered negatives is now as follows :—

English photographs	5,337
Photomicrographs	1,953
Miscellaneous	2,075

Prints to the number of 1,866 have been made in the London office, chiefly for incorporation in the Survey albums in the London and Scottish offices.

Mr. Rhodes has mounted 2,036 prints and 1,406 descriptive forms for use in the English, Scottish or provincial offices.

In Scotland 54 negatives taken by Mr. Tait and Mr. Manson of subjects of geological interest were registered and placed in the Survey collection. In addition to these Mr. Strachan secured 110 negatives of subjects taken in Orkney.

To fulfil orders from members of the public 316 enlargements, prints and lantern slides have been made from Survey negatives during 1930.

Chemistry

The number of analyses registered in this Department's records at the end of 1930 is as follows :—

English	349
Scottish	535
Irish	2
Welsh	55
Others	50
	991

Ten of the above samples have been analysed during the year and seven are still in progress of analysis. Twenty-two qualitative

(Geological Survey Office, Edinburgh

analyses have been carried out for Survey officers and many enquiries from various sources have received attention.

Accommodation

In Scotland the Office of Works began the erection of a new store room for the collections which was urgently required owing to the congestion in the office at Grange Terrace, Edinburgh. The new store is built at the west end of the office (Plate II) and is a one storey building, top lighted, and admirably designed for containing cabinets of rocks, fossils and minerals. At the end of 1930 the walls had been erected and the roof was being put on. It is expected that the building will be ready for occupation about the end of April 1931. This will not only provide accommodation for collections but will give an opportunity of rearranging the library and map series in the office building. A suitable room will also be set free for the use of enquirers who wish to consult the manuscript copies of Geological Survey maps.

An additional fire-proof room has also been secured by adaptation of one of the rooms on the ground floor. It is now possible to place all the manuscript maps, economic information, fossil-lists and boring records in the Scottish office in fire-proof strong rooms where their preservation is adequately secured.

Early in the year 1930 the foundations of the new Museum in Exhibition Road, South Kensington, had been laid and it was possible to proceed to the erection of the steel framework. At the close of the year this was practically completed, as will be seen from the photograph (Plate I, frontispiece). Meanwhile much discussion of the plans and internal arrangements has been held between the architects and engineers of H.M. Office of Works and the Director and Curator of the Museum of Practical Geology.

Museum of Practical Geology

The Museum staff have been largely occupied with the preliminary organization of the exhibits for the new Museum. This has entailed the clearing of certain cases on the principal floor and the storing of their contents, but the disturbance to the existing exhibited collections has been small and they will be kept available to the public as long as possible. An interesting loan collection, deposited by Mr. G. E. Barnard, has been arranged in a temporary case and the valuable collection of jade lent by Mr. G. W. Chater has now been acquired permanently for the Museum. Cataloguing and registration have been kept up to date and a considerable amount of photographic work both for the public and for display in the collections has been completed. The album of photographs of the Kidston Collection of fossil plants is now complete and available for consultation.

The Library continues its steady expansion and is more and more used by the public.

Research work has been confined to the magnetic and gravitational methods of geophysical surveying, accounts of which will be found elsewhere.

List of Donations during the Year 1930

Ahier, F., Esq.—Calcite and blue barytes from Crowgarth Iron Mine, Cleator Moor, Cumberland. Manganese ore (black and grey); haematite in zones on yellow calcite; from Lord Leconfield's Mines, Bigrigg, Cumberland.

Ashmore, G. P., Esq.—Small diamond crystals and fragments from the concentrates of West Africa.

Boswell, Prof. P. G. H., O.B.E., D.Sc., F.G.S.—Residues (mounted) from Post-Eocene deposits of the North Downs.

Brighton, A. G., Esq., M.A., F.G.S.—Four specimens of *Micraster sp.* from the Chalk in the neighbourhood of Saffron Walden, Essex, and Little Crishall, South Cambridgeshire.

British Empire Cancer Campaign, Secretary of.—Fluorite from Blue John Mine, Derbyshire.

Browne, J. T., Esq.—Series of freshwater Mollusca from the Coal Measures of Pendlebury Colliery, Manchester.

Canada, Director, Geological Survey of.—A series of gold, copper and other ores from Canada.

Clarkson, T., Esq., M.Inst.C.E.—Specimen of ' Kettlestone ' from Ontario, Canada.

Corporation of Manchester (*per* W. H. M. Jameson, Esq., A.M.Inst.C.E.).—A large block of banded tuff from the Borrowdale Series, found in Edmandson's Lot, Upper Mardale, Westmorland.

Davis, A. G., Esq.—A set of mounted and named Microzoa from the Lower Chalk of Merstham, Surrey.

Dewey, H., Esq., F.G.S.—Specimens of wolfram, haematite, etc. from Cornwall, hydrozincite from Carnarvon, and Old Red Sandstone showing regular jointing from Old Castle Head.

Doland, Lieut.-Col. G.F., O.B.E., J.P.—An Ammonite with associated Mollusca from the ' Kellaways Rock ' of South Cave Quarries, near Hull.

Doran, A. L., Esq.—Three junction-specimens of dykes and Lower Palaeozoic sediments from Newcastle, Co. Down.

D'Oyly Carte, Lady D.—Bog iron ore from a freshwater loch near Soval Lodge, Stornoway, Lewis.

Duchy of Cornwall, Secretary of —A varied collection of Cornish minerals.

Ducie, The Rt. Hon. the Earl of (*per* M. Horner, Esq.).—A specimen of *Loxonema sp.* from the Carboniferous Limestone of Slickstone Quarry, Tortworth, Gloucestershire.

Duke, F. W., Esq.—Iron slag with reed marks found at Gambisara, Upper River Province, Gambia.

East, F. A. H., Esq.—Cyanite Rock from Kanara, S. Bombay Presidency.

Eastwood, T., Esq., A.R.C.Sc., F.G.S.—A series of Graptolites from the Skiddaw Slates, south of Mungrisdale, Cumberland.

Edmunds, F. H., Esq., M.A., F.G.S.—A specimen of *Merodon sp.* [vomerine dentition] from the Purbeck of Inmosthay Quarry, Portland.

Gaster, C. T. A., Esq., F.G.S.—A series of Lamellibranchs from the Upper Chalk of Sussex.

Hall, Dr. A. L.—A polished slab of ' African Jade.'

Hibbert, Major A., D.S.O.—Large crystallized mass of red calcite.

Hunt, E. T., Esq.—A slab of Portland Stone, showing Wren's Quarry marks; a petrified trunk of a coniferous tree from the Portlandian of the Isle of Portland.

Iyer, Dr.—Two scapolite gneisses.

Jackson, H. Stanley, Esq.—A cut yellow olivine.

JACKSON, J. W., Esq., D.Sc., F.G.S.—A series of Goniatites from the Carboniferous zones E1, E2 and H of northern counties, including species of *Eumorphoceras, Cravenoceras, Homoceras* and *Homoceratoides*.

JONES, F., Esq., M.Sc., F.G.S.—Rock specimen from Croft, Leicestershire, showing analcite.

KEEVIL, J. J., Esq.—A specimen of *Spirifer verneuili* Murchison, from the Upper Devonian of Delabole, Cornwall.

LAING, W. ALLAN, Esq.—Polished slab of smaragdite with saussurite and one of ' Emerald Pearl ' granite.

LEE, ROBERT G., Esq.—' Cannon-Ball ' (Magnesian Limestone), Sunderland.

LEESE, C. E., Esq., B.Sc.—Specimen of Calc-flinta from Warren's Quarry, Camelford.

LEWIS, H. P., Esq., M.A., F.G.S.—Two specimens and a microscope-section of *Bolopora undosa* Lewis, from the Garth Grit (Basal Arenig) of Ffestiniog, North Wales, and a microscope-section from the Basement Arenig Conglomerate of Ramsey Island, South Wales.

MARSDEN, J. G., Esq.—A tooth of *Equus caballus* Linnaeus, from the Peat of Dewe's Farm, near Harefield, Middlesex.

MOORE, E. W. J., Esq., B.Sc., A.I.C.—Specimens of *Goniatites* and *Sagittoceras* from the Bowland Shales of Dinckley, Lancashire ; and a specimen of *Gastrioceras listeri* (Martin) from the Lower Coal Measures (Bullion Band) of Green's Clough, Portsmouth, near Todmorden, Yorkshire.

NOOTT, R. W., Esq.—A specimen of *Spondylus spinosus* (J. Sowerby), in flint, from Broadstairs, Kent.

NORWEGIAN CHAMBER OF COMMERCE. — Three rock specimens from Valberg Quarry, Kragero, Norway.

OLDING, MISS C. ALICE, bequeathed by (*per* Miss C. M. Sullivan).—A plaque in white and green banded marble with a design of trees in low relief, on carved wood stand.

OLIVER, HENRY, Esq.—Bangle in quartz of amethyst colour.

OSMAN, C. W., Esq., M.INST.C.E., F.G.S.—A series of fossils from the Chalk Marl of Abbotscliff Trial Pit and Folkestone Shore, Kent. Twenty-six microscope-sections and thirteen specimens of rocks.

OSWALD, FELIX, Esq., B.A., D.Sc., F.G.S.—Three specimens from the Middle Cambrian of Porth-y-rhaw, near St. Davids, containing *Microdiscus punctatus* Salter, *Agnostus* cf. *rotundus* Grönwall, and *Holocephalina primordialis* Salter.

PRINGLE, J., Esq., F.G.S.—A wing of *Soomylacris strahani* Bolton (type of the species), from the Mynyddislwyn Vein worked in the Gelli-deg level of Maes-y-cwmmer, Monmouthshire ; and a specimen from the Bifidus Shales of Porth Llauog, Ramsey Island, with *Tetragraptus bigsbyi* (Hall), etc. Three rock specimens from Careg Rhosson, Bishop and Clerks Group.

ROBERTS, HUGH, M., Esq.—Haematite and limonite from the Mesabi and Vermillion Ranges, Minnesota.

SCHOELLER, W. R., Esq.—A boulder of cervantite from China.

SHANNON, DR. W. G.—Seventeen microscope-sections from one-inch Sheet 350.

SHERIDAN, S., Esq.—Manganese ore from Djebel Batoum, South Tunis.

SMITH, BERNARD, Esq., M.A., Sc.D.—Specimen of Glacial Drift, Seascale, Cumberland.

STANNARD, G. F., Esq.—Vermiculite (zonolite) from Libby, Montana, U.S.A.

SULLIVAN, MISS CARRIE M., F.R.G.S.—Inlaid table in marbles collected from the shore at Baiae and derived from submerged buildings.

SWEDEN, DIRECTOR, GEOLOGICAL SURVEY OF.—A series representing the cupriferous pyrite ore of Åsen and the copper-gold arsenic ore of Boliden.

SYKES, S., Esq.—A series of rocks illustrating the occurrence of cassiterite at Mutue Fides Mine, Transvaal.

TRAILL, CAPTAIN C. J.—Section of a tree-trunk from the pitch lake of Trinidad.

TRUEMAN, A. E., Prof., D.Sc., F.G.S.—A type specimen of *Edestus pringlei* Watson, from the Lower Cefn Coed Marine Band (Orthoceras bed), Coal Measures of Cefn Coed Colliery, near Crynant, South Wales.

VIVIAN, STEPHEN, ESQ.—Copper ore from the Coruña Copper Concessions, Spain; samples of ore and schist accompanying the ore.

WARE, W. D., ESQ.—A series of specimens from various seams in the Coal Measures of South Wales.

WOODHOUSE, C. A., ESQ.—A fine example of ' Desert Rose ' from Ghadames, N. Africa.

YORKSHIRE AMALGAMATED PRODUCTS, LTD. (*per* E. W. Oakes, Esq.).—An Ammonite from the ' Kellaways Rock ' of their South Cave Quarries, near Hull.

YOUNG, G. W., ESQ., F.G.S., the Executors of the late.—A large series of zonally collected fossils from the Chalk of Surrey.

JOHN S. FLETT,
Director.

II. DISTRICT REPORTS

(A)—ENGLAND AND WALES

1. SOUTHERN DISTRICT

HENRY DEWEY, District Geologist.
E. E. L. DIXON, B.Sc.
R.L. SHERLOCK, D.Sc.
H. G. DINES, A.R.S.M., A.M. Inst. C.E. } Senior Geologists.
W. LLOYD, B.Sc.
F. H. EDMUNDS, M.A. } Geologists.

THE survey of the Reigate map (Sheet 286) by Messrs. Dines and Edmunds was completed during the autumn and the dry-proofing of the one-inch map has been started, while some progress has been made with the descriptive memoir. Fresh ground was broken in the Sevenoaks map (Sheet 287) by Mr. Dines who mapped several square miles north of that town. Mr. Dines has made a special study of the distribution of the valuable beds of fuller's earth near Nutfield. During the survey he received much help from Mr. O. F. Keevil, Manager of the Fuller's Earth Union, Ltd., to whom our thanks are due.

In the spring Mr. Edmunds in collaboration with Mr. R. J. Schaffer undertook the examination of the Portland Stone formation and selected specimens for testing purposes at the Building Research Station, Watford : he also supervised the photographic work in the districts concerned. He was fortunately able to obtain for exhibition in the Museum a large block of stone bearing the mason's mark of Sir Christopher Wren.

In February Mr. Dines completed a survey of the Rothamsted Experimental Fields of the Lawes Agricultural Trust. The work followed the map of the late H. B. Woodward, but differentiated for purposes of soil study the textures of the Clay-with-flints. Two blocks of sandstone containing moulds of Pliocene shells were exposed in trenches and a description of them has been published.[1]

During March Mr. Dines was occupied at the Field Meeting and Conference held by the Ministry of Agriculture and Fisheries at Bangor, North Wales and made a reconnaissance survey of an area near College Farm at Aber, of the University College, Bangor, where the sub-soil consists of boulder-clay formed from the Triassic beds lying further north. The clay covers the coastal plain but does not rise higher than about 150 ft. above O.D. A sea-cut platform, in the clay, terminated inland by a sharp rise just below 100 ft. above O.D., apart from local tracts of gravel or shingle, is bare of deposits.

[1] ' Summary of Progress ' for 1929, Part iii (*Mem. Geol. Surv.*), 1930, p. 1.

A start was made in the summer upon the examination of the Kent coalfield by Mr. Dines : all the mines and the working coal seams were visited and a large number of sections of boreholes and shafts was collected. The work is in progress.

The number of enquiries relating to the south-east of England by other Government Departments, Public Bodies and the general public still increases and many are of consequence as involving expenditure of large sums of money. Mr. Dewey has spent much time on the correlation and classification of records of boreholes in the south of England. Messrs. Dixon and Sherlock were transferred in the summer to the Southern District and commenced work in the Biggleswade area. Mr. Dixon remarks that the Lower Greensand comprises a group of thin ferruginous glauconitic sandstones and sands of a Carstone facies, with scattered phosphatic nodules but no beds of phosphates. There has not been much quarrying at its outcrop at Gransden and Bourn, but the formation is of economic importance from the point of view of water supply, as it is the source of the East Hunts. Water Company's supply at their Bourn works and of many smaller wells. Its total thickness appears usually to be about 20 ft. : its greatest known thickness in the area is 30 ft. at Hatley St. George. In the Rhee valley many wells have artesian flows.

No evidence has been obtained as to which Jurassic clay underlies the Lower Greensand. The Gault which is no longer worked or satisfactorily exposed in the area appears from material got from recent boreholes at New Wimpole and Orwell to be almost unfossiliferous. In the boreholes the base consists of eleven feet of dark sandy clay with small pebbles, up to an inch in length, underlying a bed of black phosphatic nodules and separated by a few inches of buff loam from hard Carstone with small pebbles. The abrupt change suggests a break between the Carstone and the Gault ; whereas the presence of abundant round ferruginous grains, some brilliantly polished and apparently ooliths, alike in the Carstone, the loam and the basal Gault points to conformity of the beds as at Hunstanton.[1] The presence in the basal Gault in the borings of fragments and pebbles of ferruginous or glauconitic sandstone like Carstone, however, further suggests a break. A worn phosphatised fossil from the same horizon has been identified by Mr. Chatwin as a perisphinctid ammonite from the Upper Kimmeridge Beds. The full thickness of the Gault as indicated by well records appears to be between 125 ft. and 150 ft.

In the Chalk the Chalk Marl as a rule makes little feature with the Gault below but, though the Totternhoe Stone in this area is not exposed, it is separable by a feature from the somewhat harder chalk above.

The boulder-clay, together probably with the gravel that locally seems to underlie it, belongs almost wholly to the older Glacial

[1] Rastall, R. H., 'The Petrography of the Hunstanton Red Chalk,' *Geol. Mag.*, 1930, pp. 436-58.

drift. A few small drumlins at Kingston are referred to the newer drift. The Valley Gravels are also divisible into two sets, the older of which is intermediate in age between the two glaciations. No fossils have been found in this area but the older gravels belong to the same terrace as those at Grantchester which have yielded mammals and Mollusca and are correlated with the Taplow Terrace of the Thames valley.

Dr. R. L. Sherlock was engaged during the autumn in re-surveying the area around Shefford, Beds. (Sheet 204). In this region the Lower Greensand forms a light sandy soil which is largely park land. The few exposures of Greensand are devoid of fossils. The Gault forms a low plateau for the greater part covered by Drift. The only good exposure in the Gault is in a clay-pit, a mile south-east of Shefford, but fossils are few and poor here. Only 80 yds. north-west of this pit in bare Gault there is a sand and gravel pit in which Gault has not been touched even at a depth of 20 ft. The channel in which the Drift lies cannot be followed very far.

An area of Glacial Gravel, not previously mapped, covers much of the village of Meppershall, and small kame-like patches of sand, or sand and gravel, have been found in the park of Chicksands Priory.

A division of the spreads of gravel shown on the Old Series map, between Shefford and Biggleswade, into Glacial and River gravels has been commenced.

Work was continued by Mr. Edmunds in the Saffron Walden area (Sheet 205) and the map is being prepared. Mr. Edmunds has his contribution to the memoir well in hand. In 1929 Messrs. Dines and Edmunds while examining deposits of gravel and sand in the vicinity of Cambridge ascribed a glacier-lake origin to some of the drifts, and work during the past field season has confirmed their inferences, while Mr. Dixon has observed erosion features in the adjacent area (Biggleswade, Sheet 204) to the west that he interprets as strand-lines of this lake. For purposes of description the name Lake Cambridge has been suggested.

In the Saffron Walden district Mr. Edmunds reports that the boundary line at the base of the Upper Chalk along the whole length of the escarpment has been revised; the necessity for this revision was shown by Mr. A. G. Brighton, M.A.,[1] to whom our thanks are due for assistance in the field.

Mr. Edmunds finds strong evidences of a glaciation in the Cambridge area subsequent to that of the Chalky Boulder Clay episode and he is of opinion that the whole of the Cam valley gravels are later in date than that Boulder Clay.

From fresh evidence obtained during his work in the district Mr. Edmunds has been led to conclude that a wrong interpretation of a record of an important borehole at Whittlesford was made by the late Sir Aubrey Strahan. A borehole at ' The Cabin ' Whittles-

1 ' Notes on the Middle and Upper Chalk of the Cambridge District,' *Geol. Mag.*, 1928, pp. 368-371.

ford was described[1] as being in Glacial drift to a depth of 455 ft. : the record however shows a normal sequence of beds for the neighbourhood and should read :—

		Thickness Ft.	Depth Ft.
	Top soil and gravel	15	15
Lower Chalk	Clunch (water at 120 ft.)	142	157
Gault	Blue clay	147	304
	Marl	59	363
Lower Greensand	Lower Greensand (a brilliant grass green sandstone when fresh, but losing its colour when exposed) ...	7	370
	Rock, light colour	34	404
? Kimmeridge Clay	Alternate seams of soft and hard materials varying from pale-blue to terra-cotta	46	450
	Rock, chocolate, containing marcasite nodules to		455

The borehole penetrated fifteen feet of gravel and 142 feet of Lower Chalk : it was a chisel bore and the work took about three years. These facts offer an explanation of the presence of chalk particles in the clay below the Chalk and also of the occurrence of flints near the bottom of the borehole. In the 1914 account the thickness of the Lower Chalk of Cambridge is calculated at 365 feet ; whereas Jukes-Browne[2] formerly had estimated it at about 170 feet, and this thickness has been found to be approximately correct. . There is an error in the location of the borehole, which lies north-west and not west, as stated, of Whittlesford Station, and the surface level is 80 ft. and not 120 ft. above O.D. The supposed glacial channel of more than 455 ft. depth does not therefore exist. It must be emphasized, however, that the existence of a glacial channel of much less depth has been proved by other borehole records in the Cam valley.

Mr. Lloyd finished the revision of the Torquay area and the memoir is nearly complete. He was transferred during the autumn to the Bridport area for its survey on maps of the six-inch to one mile scale, and has already made some progress. No new series geological map (Sheet 327) of this district has hitherto been published, and as it is a district of much interest comprising Liassic, Jurassic and Cretaceous formations on which research work has been published by Dr. Lang and Mr. L. Richardson, the map when complete is likely to be of much value for teaching purposes.

H. DEWEY.

[1] 'Summary of Progress' for 1914 (*Mem. Geol. Surv.*), 1915, Appendix I, p. 65.
[2] 'The Cretaceous Rocks of Britain' (*Mem. Geol. Surv.*), vol. ii, 1903, p. 193.

2. MIDLANDS AND SOUTH WALES DISTRICTS

BERNARD SMITH, M.A., Sc.D., District Geologist.
R. W. POCOCK, M.Sc.
T. H. WHITEHEAD, M.Sc., A.R.C.Sc.
T. ROBERTSON, B.Sc., Ph.D., A.Inst.M.M.
} Senior Geologists.
T. N. GEORGE, M.Sc., Ph.D., Geologist.

DURING the year field work in the Midlands was carried on in a tract covered by the western part of Sheet 167 (Dudley) and the eastern margin of Sheet 166 (Church Stretton). Mr. Pocock was engaged in the western part of the district around Chelmarsh, Glazeley, Sidbury and Stottesdon ; whilst Mr. Whitehead worked the ground north-east of Kidderminster, and that between Enville and the River Severn near Quatt and Alveley. Dr. George joined the staff late in the season and received training in field-mapping from both of the above-mentioned officers.

The preparation of the maps and memoir on the Shrewsbury district (Sheet 152) has been carried on, and in this work Mr. Cantrill, Mr. Wedd and Dr. Robertson have participated.

Progress in the South Wales coalfield has been confined to the elucidation in the field of minor questions that have arisen in preparing a new edition of the Merthyr Tydfil memoir. The work of bringing this memoir up to date has occupied much of Dr. Robertson's time during the year, and it is now nearing completion. It has been found possible to keep in touch with recent developments in South Wales—including new drifts to the Nine-Feet at Ynisarwed and Cefn-Coed, and a sinking from the Nine-Feet to the Gellidêg Coal at Merthyr Vale.

In addition to numerous enquiries that have been answered by the staff upon geological questions from many parts of the English Midlands and Wales, Dr. Smith has examined a deposit of copper ore at Cleator Moor, Cumberland, and studied the new Lake Vyrnwy tunnel-aqueduct of the Liverpool Corporation ; whilst Dr. George has examined the works in the Milwr sea-level tunnel at the Halkyn Mines in North Wales.

Old Red Sandstone.—Much of the area surveyed by Mr. Pocock is occupied by beds of Lower Old Red Sandstone age, and fish-remains have been detected at several localities.

At the north-eastern end of the Clee Hill syncline Upper Old Red Sandstone (Farlow Sandstone) has been mapped where it emerges from beneath the Carboniferous Limestone. It consists of soft pale yellow sandstone with scattered pebbles and a conglomerate, overlying brownish sandstones and marls. The yellow sandstone is succeeded by greenish calcareous grits capped by a coarse conglomerate which underlies the limestone.

Lower Carboniferous.—A short section of the outcrop of the Carboniferous Limestone falls within the area mapped by Mr. Pocock at the north-eastern end of the Clee Hill syncline. All the limestone examined appears to belong to the Cleistopora Zone and its thickness is estimated at about 250 ft.

The Carboniferous Limestone is succeeded by conglomerate and grey and yellow sandstones (Cornbrook Sandstone) with *Stigmaria*, etc. A seam of coal in the sandstone has been worked about 600 yds. south of Prescott House. Within the limited area surveyed the relations of the Cornbrook Sandstone to the Carboniferous Limestone have not yet been determined.

Coal Measures.—It has not so far been decided how much of the Etruria Marl Group is present at outcrop north of Billingsley, west of the Severn valley. Here the higher, or Sulphur Coal Group (Halesowen Group) transgresses the underlying Coal Measures in a northern direction and rests upon the Old Red Sandstone.

The mapping of the Deuxhill outlier—where the Sulphur Coal Group overlies the Old Red Sandstone—has been completed by Mr. Pocock and a Spirorbis limestone traced at intervals within its western boundary. In the main outcrop this limestone has not been detected *in situ* south of Bridgnorth.

The rock, coloured on the old map as Millstone Grit, at Bagginswood south-east of Stottesdon, is a fine to coarse white or greyish ganister with rootlets, and appears to occur actually in the basal beds of the Sweet Coal Group (Middle Coal Measures). It has been traced, at this horizon, northwards to Billingsley and Wadeley, beyond which there are indications that it is transgressed by the Sulphur Coal Group. Small outliers of this ganister, on Old Red Sandstone, have been detected half a mile and 1¾ miles south-west of Eudon George, but there is no indication of this rock beneath the measures of the Deuxhill outlier. The ganister appears to mark the base of the Sweet Coal Group south-east of Bagginswood, and is present also in the small patch of Coal Measures at Cleobury Mortimer, which therefore, in all probability belong to the same group.

East of the Severn valley Mr. Whitehead finds that, north of Shatterford, on the west side of the Trimpley anticline, the grey measures associated with the Shatterford basalt are succeeded by a fairly well-defined group of purple marls with espley-like grits, about 400 ft. thick. This group, resembling Etruria Marls, is in turn succeeded by a group of greenish sandstones and grey shales with thin coals, resembling the Halesowen Group of South Staffordshire. These beds are followed by the Keele Group with apparent conformity.

A noteworthy feature of the Keele Beds in the area near Quatt and Alveley is the variability in the lithological characters of the arenaceous beds. Almost every type known in the Upper Coal Measures of the Midlands can be found, though the red sandstones

and conglomeratic cornstones characteristic of the Keele Group prevail. In the upper part of the group, near Dudmaston Hall and Hampton Loade, there occur lenticles of conglomerate and breccia. These contain pebbles and fragments of limestone and chert, and when the constituents are well rounded the lenticles resemble the Calcareous Conglomerates of the Enville Beds, whilst those in which the fragments are angular are very similar to the finer varieties of the Clent Breccia. Spirorbis limestones are numerous in the Keele Beds of this area. Most of them seem to be lenticles of very limited extent, but a persistent bed, in places 3 ft. or more in thickness, occurs near the base of the group.[1]

The mapping of the Enville Beds has been completed, and, as a result, Mr. Whitehead concludes that there is definite evidence of an unconformity at the base of the Clent (Enville) Breccia, for, whilst in the neighbourhood of Four Ashes the thickness at the outcrop of the underlying Calcareous Conglomerate Group cannot be less than 300 ft., near Compton, south of the Sheepwalks, there is room for no more than 150 ft. and only one calcareous band remains. There appears to be overstep on the part of the Breccia as the axis of the Trimpley anticline is approached.

The relations of two outliers of the Breccia, respectively north and south-south-east of Coton Hall, to the Calcareous Conglomerate Group appear, also, to indicate unconformity.

Igneous Rocks.—The greater part of the Kinlet basalt has been mapped by Mr. Pocock, who finds that the further evidence collected confirms his conclusion[2] that it is a lava of Coal Measures age.

Drift.—The area surveyed by Mr. Whitehead is free from true Glacial deposits, though large boulders of Scottish granite occur near Quatt and Wooton. These lie on or near broad flats underlain by gravel that contains northern erratics and is probably connected with the Main or Fluvio-glacial Terrace of the River Severn.[3] Pebbles of northern origin extend much farther south in the terrace gravels of the Severn and the Stour. The terraces of the latter have been mapped as far as the northern outskirts of Kidderminster. Above the terrace with northern erratics referred to in last year's *Summary of Progress*[4] a higher terrace with gravel that seems to be of local origin appears in the neighbourhood of Caunsall. Lower terraces also occur; at Caunsall no less than five can be distinguished. To the east of the Stour valley other gravels form a capping to low hills, their base nowhere descending much below 300 ft.

A bench at about 300 ft. is a well-marked feature in the area near Kinver and Wolverley. This is covered by a spread of pebbles

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1 *See* Cantrill, T. C., *Quart. Journ. Geol. Soc.*, vol. li, 1895, p. 533.
2 'The Age of the Midland Basalts,' *Quart. Journ. Geol. Soc.*, vol. lxxxvii, 1931, p. 1.
3 Wills, L. J., *Quart. Journ. Geol. Soc.*, vol. lxxx, 1924, p. 295.
4 Part i, (*Mem. Geol. Surv.*), 1930, p. 52.

derived, in the neighbourhood of the gravels just referred to, from those gravels ; near the Bunter Pebble Beds escarpment, from the Pebble Beds, and, at Compton, from the Breccia of the Sheepwalks. Considerable erosion has taken place since the formation of the surface of which this bench is a relic, and, in some places, has isolated the material lying upon the bench from its source.

BERNARD SMITH.

3. YORKSHIRE DISTRICT

Headquarters : York

C. E. N. Bromehead, B.A., District Geologist.
D. A. Wray, Ph.D., M.Sc., Senior Geologist.
J. V. Stephens, B.Sc., B.Eng.
Wilfrid Edwards, M.A.
G. H. Mitchell, Ph.D., M.Sc., D.I.C. } Geologists.

IN the Yorkshire District the map of the country around Holmfirth (Sheet 86, Glossop) is being engraved and the accompanying memoir has been largely written. Field work has been done on the Wakefield and Barnsley Sheets. In the former Mr. Edwards has carried his work in the north eastwards in continuation of that in the Halifax and Huddersfield Sheet. An area extending from Leeds to the outskirts of Wakefield has been mapped, as well as the main part of Leeds lying in the south-west of Sheet 70.

The strata examined include the Coal Measures from their base to above the Stanley coals, a column over 2,500 ft. thick, containing 15 workable coal seams. The main seams now worked are, in the Lower Coal Measures the Black Bed, about 30 in., Crow Coal, 26 to 28 in., and Beeston Bed, up to 9 ft. with partings, and in the Middle Coal Measures the Middleton Main, 4 to 5 ft. Many other seams are occasionally worked at the outcrop. Some of the thicker seams in the Middle Coal Measures are practically exhausted, and their exploitation has been abandoned.

Fireclay, brick-shales, ironstone, building stone, sand and gravel are also being obtained from the area. The Better Bed Fireclay, 2 ft. 8 in. to 5 ft. 9 in. thick, is much worked in the Leeds area for the manufacture of refractory and sanitary ware and various kinds of pottery. Several thick beds of ganister and fireclay have been proved in borings underneath Leeds, but in the open country to the south they are below the limit of economic working for these materials. Red bricks are made on a large scale in the area, the ordinary Coal Measures mudstones being quarried at any convenient place. The chief clay-pits now open are at Beeston (strata below the Black Bed and Beeston Bed coals), Middleton (strata below the Thornhill Rock) and Robin Hood (strata above and below the Haigh Moor Coal). Ironstone occurs as nodular bands at many horizons, the best known being that above the Black Bed Coal. The Carbonicola band above the Middleton Bed is often rich in iron. Ironstone is now only worked in a small way, chiefly as a by-product. Building stone is raised from deep quarries in the Thornhill Rock at Woodkirk and Robin Hood, and is of such excellent quality as to be sent all over the country for constructional work. Gravel with sand occurs as a deposit 25 to 30 ft. thick

beneath the wide alluvial flat of the Aire south-east of Leeds, and is dug on a large scale chiefly for concrete manufacture.

Besides these mineral resources, underground water for industrial supplies is important in the Leeds area. It may be obtained from the Elland Flags underlying much of Leeds at shallow depths, or from the Rough Rock at 600 to 1,000 ft. The Elland Flags may range up to 300 ft. thick, but are not a reliable source of supply, the water varying greatly in quantity and quality. The Rough Rock is a coarse grit 60 to 100 ft. thick and affords better chances of obtaining abundant and soft water, although a fairly high degree of temporary hardness may be encountered. Southwards these beds reach far greater depths and their productiveness is likely to diminish.

Beds with *Carbonicola* and other freshwater fossils occur at many horizons in these measures. Good collections have been obtained from the roof of the Crow Coal at Middleton Colliery and from the well-known horizon above the Haigh Moor Coal at Robin Hood.[1]

Heavy faulting is found all over the area, the two main trends being north-east and east-south-east ; the former is dominant in the Leeds neighbourhood.

Dr. Wray has continued the survey in the southern part of the Wakefield and northern part of the Barnsley Sheets. Mr. Bromehead did a little field work south of Dr. Wray around Cawthorne and Silkstone, and Mr. Stephens to the south near the Don valley. The mapping of the Lower Coal Measures has been completed as far south as the Penistone and Barnsley Railway. The Whinmoor Coal is still being worked at shallow depths at several small pits, but other seams, such as the Charlton Brook, Cumberworth Thin and Black Band coals are of little value and difficult to trace.

Near Thurgoland Mr. Stephens has discovered a band containing *Carbonicola* in the Penistone Flag Series, which may prove to be a useful datum-line. He has also mapped the lower part of the Lower Coal Measures and the upper Millstone Grits around Stocksbridge and Broomhead, where the ganister and pot-clay industry is important.

Mr. Bromehead and Dr. Wray have completed the mapping of the confusing and obscure ground between Clayton West and Silkstone.[2] The general succession here and its correlation with other areas had been previously elucidated by Dr. Wray, but the local failure of many of the seams made the tracing of outcrops very difficult. For instance, Mr. Bromehead finds that a dirt parting in the Silkstone Coal, 9 in. thick at Silkstone, increases to 4 ft. 6 in. at Norcroft ; at Cawthorne the two parts of the seam can be mapped separately ; but in Cannon Hall Park and the woods to the south-west only an inch or two of coal remains, apparently representing the upper band. This break associates itself with a vague zone or line extending east and west through Ryhill, Woolley and Clayton West, which appears to mark the boundary between two distinct areas referred

[1] *Trans. Leeds Geol. Assoc.*, Part xvii, 1911-13, pp. 31-35.
[2] ' Summary of Progress ' for 1927, Part i (*Mem. Geol. Surv.*), 1928, p. 45.

to respectively as the West and South Yorkshire coalfields. Practically all the seams exhibit marked changes when traced across this zone. The majority of the seams below the horizon of the Barnsley or Gawthorpe become thin and unworkable in the country between Woolley and Clayton West. A useful horizon in this area is the Tankersley Ironstone with *Carbonicola* : in the heavily wooded area several ancient bloomeries, located by means of slag heaps, have assisted in tracing its position.

Intensive work in the preparation of the memoir on the area already mapped in Sheet 86 has shown that the line of contemporary disturbance just mentioned can be extended westwards to the neighbourhood of Holme ; marked thinning of all parts of the Lower Coal Measures, with the loss of the Better Bed and Black Bed, and also of much of the Millstone Grit sequence takes place along it.

Dr. Wray states that the New Hards Coal is still being mined in the Clayton West district, and in some workings has been found to contain occasional large smooth and well-rounded boulders of a very fine-grained grey quartzite. Similar boulders of foreign material have been recorded from time to time from various seams in the Bradford and Leeds districts.

The New Hards or Middleton Main has been extensively mined in the Wakefield district, though here it is usually known as the Silkstone. It occurs, however, at a higher horizon in the succession than the true Silkstone seam of South Yorkshire, and it appears inadvisable to employ this term, despite its wide and almost universal usage by mining engineers and surveyors in the Wakefield and Normanton districts. An interesting feature in the New Hards seam in workings immediately to the west of the city of Wakefield is the presence of faults which have a throw of 30 ft. or more in that seam, but are not met with in the overlying Haigh Moor workings. Professor Kendall has observed a similar fault in the workings at the Whitwood Collieries near Normanton.

The several seams in the measures above the Barnsley Coal have all been worked in one place or another.

The Mapplewell or Kents Thick of the Barnsley district is, however, not recognisable to the north of Crigglestone ; in fact the whole of the measures between the Barnsley and Woodmoor or Meltonfield Coal diminish in thickness northwards ; this decrease appears to be mainly caused by the thinning out of the measures among which the Mapplewell seam occurs.

The Beamshaw Coal, on the other hand, which is in two beds to the south of Crigglestone, appears to be represented by an important seam in the Wakefield district known as the Stanley Main.

The succeeding Winter Coal is an excellent seam to the south of Wakefield ; to the north of that town it is represented by the inferior Stanley Scale Coal.

An important horizon which is likely to be of considerable value for the purposes of correlation is the Two-Foot or Royston Coal. There are shallow workings in this seam to the north of

Barnsley though usually it is too thin and of too inferior a quality to mine. The roof shales of this coal yield *Lingula sp.* and *Posidonomya sulcata* Hind, and it seems highly probable that the so-called 'Winter' or 'Abdy' Coal of the deeper collieries around Doncaster and in the Concealed Coalfield, which has a marine roof, is in reality the local representative of the Two-Foot Coal[1]. The Wathwood, Woodmoor or Summer Coal, which is also usually known in South Yorkshire as the Meltonfield Coal, is a seam of fair importance to the south and south-east of Wakefield, and is likely to be developed more extensively when the more important seams have been exhausted. To the north-east of Wakefield, however, it is a very inferior seam with many dirt partings and quite unworkable.

Dr. Mitchell spent much of the early part of the year in an examination of the Magnesian Limestone throughout the country in collaboration with the Building Research Station. He afterwards continued his mapping of the eastern part of the Barnsley Sheet, mainly on the Permian rocks, but including an area occupied by the higher part of the Middle Coal Measures.

To the west of Conisborough the Denaby Coal (probably the equivalent of the Shafton) has been traced from near Denaby Main Colliery, in the shafts of which it occurs at a depth of 30 ft., by way of Denaby Wood south-westwards to near Hooton Roberts. A large number of old overgrown bell-pits testify to the working of the coal in the past.

A thick sandstone lies below the coal and is some 125 ft. thick. Being well-bedded and jointed, with thick beds, it has been worked in several quarries along the outcrop. This outcrop is marked by a fine scarp extending from near Denaby Main south-westwards towards Thrybergh. An outlier of the same rock is seen at Peas Hill Plantation half a mile west of Denaby village, where it is bounded on the south-east by a large fault running N.E.-S.W. The highest members of the Coal Measures consist of red shales and sandstones which are seen on the South Yorkshire Joint Railway at the north-east end of Conisborough Tunnel, at a roadside section at Edlington Hill and at Ashfield Clay Works, Conisborough. At the latter locality the sandstones yield good plant-remains.

The basal sands of the Permian occur at Ashfield Clay Works resting on red-stained Coal Measures. They are about 5 ft. thick and consist of sands with pebbles. Overlying them are red and grey marls succeeded by oolites.

The Lower Magnesian Limestones form a strong escarpment extending from Hooton Roberts to Conisborough. The lowest limestones to the south-west are mainly close-grained, hard and compact, but to the north-east oolites come in at the base and are prominent in North Cliff Quarry, Conisborough. The continuity of the outcrop is broken by N.E.-S.W. faults at Conisborough where the Castle is built on a thin outlier of the lowest limestones.

[1] Barker, W. R. and D. A. Wray, 'Marine Horizons in the Coal Measures of the Barnsley District,' *Proc. Yorks. Geol. Soc.*, vol. xxi, 1931, pp. 322-323.

The railway cuttings and quarry sections near Conisborough give sections in the Lower and Middle Limestones as well as in the Middle Marls and Upper Limestones. Thus it appears that the junction between the Lower and Middle Limestones is marked by a bed of porous cellular limestone observed in the Dearne valley railway cutting near Cliff House, Conisborough, and also in Conisborough Cliff Quarry.

The Middle Marls are seen in the railway line near Martin Wells Farm, Edlington. Here red and greenish-grey marls occur with gypsum bands and are overlain by the thin-bedded grey and buff Upper Limestones. An excellent section of these beds also occurs in the L.N.E.R. Sheffield-Doncaster line near Warmsworth. They are here very thin. The lowest beds of the Upper Limestones contain abundant sand grains which are well seen at Martin Wells Farm cutting and in the cutting near Warmsworth. Traces of Upper Permian Marls rest on the Upper Limestones in many exposures on Hexthorpe Flats.

The Triassic Sandstones may be seen in several quarries at Balby. They are very soft, red in colour and contain occasional pebbles and marl pellets.

The area comes within the belt affected by the Don faults, and several powerful N.E.-S.W. faults dislocate the strata. These cause considerable difficulties in working the coal seams and much interesting information is forthcoming as to the structure of the country by a study of the contours of the Barnsley and Parkgate seams in the underground workings. The change of strike in the neighbourhood of the Don faults is very great, ranging from N.W.-S.E. through N.E.-S.W. to E.N.E.-W.S.W.

Apart from routine field work, a shaft sinking near Sheffield was under observation, and periodic visits were made to examine sections exposed in a new railway between Ollerton and Farnsfield and in widening operations at Ambergate.

Dr. Wray has collaborated with the Fuel Research officer at Sheffield in a study of the Better Bed Coal and its correlation with the Lancashire field. He has also been assisted by Dr. Trueman in an investigation of the non-marine lamellibranchs of the Yorkshire Coal Measures.

In August many delegates from the International Botanical Congress at Cambridge visited Yorkshire and were conducted to collieries in the Barnsley district.

A box of specimens has been discovered in the Leeds City Museum, labelled as from the Askern Colliery sinking; these show that a marine horizon occurs here in the measures about 800 ft. above the Barnsley Coal, and there is little doubt that this is the local representative of the Mansfield Marine Bed.

Late in the year a local committee of the Physical and Chemical Survey of the National Coal Resources was constituted for the West Yorkshire area. Mr. Bromehead already represented the Geological Survey on the committees for South Yorkshire and for

Notts. and Derby. The entire area of the coalfield is therefore covered. The correlation of the work of these three committees is likely to yield results of great geological importance apart from their primary objects.

We must acknowledge with thanks the assistance of several firms of Mining Agents who have provided a wealth of information on the Coal Measures surveyed, and of the Colliery Companies working in the area. We are also indebted to Mr. C. W. Hart, late Sewerage Engineer to the Corporation of Leeds, for the carefully recorded geological section of the new sewer across Leeds, which has been invaluable in mapping the area.

C. N. BROMEHEAD.

4. LANCASHIRE DISTRICT

Headquarters : Manchester

W. B. WRIGHT, Sc.D., M.I.M.E., District Geologist.
R. L. SHERLOCK, D.Sc., A.R.C.Sc., Senior Geologist.
L. H. TONKS, M.Sc.
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A. E. MOURANT, B.A.

THE memoir on Sheet 85 (Manchester) is now printing and will shortly be published. Field work on Sheet 84 (Wigan) has been completed and the collection of mining information is well advanced. The plans of abandoned mines deposited in the Mines Department have now been examined. This has been an unusually heavy piece of work both on account of the number of the plans and the complexity of the faulting. A certain amount of mining information still remains to be collected at working collieries, and the taking out of underground tunnel sections is in progress. The non-marine Mollusca which proved so useful for correlation purposes in Sheet 85, seem likely to be of service in the Wigan area also. It is hoped that the first six-inch maps of Sheet 84 will be passed for dry-proofing during the coming year.

Dr. Sherlock has completed the mapping of the St. Helens area and has been transferred to London.

Mr. Tonks has been responsible for the western and north-western portions of the Sheet between Knowsley, Ormskirk and Wigan. Around Knowsley and Simonswood the solid rocks consist of Lower Coal Measures and Bunter Sandstone. Lower Coal Measures sandstones are exposed in Knowsley Park, where a " Mountain Mine " was worked many years ago ; and these rocks have been proved in borings north of Simonswood Moss, south and west of the Middle Coal Measures of the Bickerstaffe-Rainford area. These and other borings show a great expansion of the Lower Measures to the west, comparable with that already described in the Millstone Grit.[1] An attempt to study the faunas of the lower part of the Middle Coal Measures and of the measures between the Arley and Upper Mountain Mines at Bickerstaffe Colliery on the extreme west of the coalfield proved unsuccessful, because, in the tunnels available, faulting and the abnormal development of sandy strata cut out the known fossil bands.

The boundary between the exposed coalfield and the Triassic rocks to the west is probably a fault on or near the line mapped by Hull, but the line is nowhere seen and mining operations have passed westwards into such extremely faulted ground that coal-getting

[1] Tonks, L. H. and W. B. Wright, ' The South-Westerly Thickening of the Millstone Grit in Lancashire,' ' Summary of Progress ' for 1923 (*Mem. Geol. Surv.*), 1924, p. 150.

stopped before the boundary or any major fault was proved. In this connexion it is interesting to note that at Barrow Nook, south of Bickerstaffe, workings in the Middle Coal Measures indicate that these beds are thrown out by a large fault bringing in Lower Coal Measures before the red sandstone is reached. All along the western flank of the coalfield therefore, it is the Lower Coal Measures which are faulted against the Trias, and as no higher measures have been found west of this, extensions of the coalfield beneath the Triassic cover in this direction are less probable than elsewhere.

Shirdley Hill Sands occupy a considerable area in the south-western part of Sheet 84, and good sections may be seen in sand-pits at the end of the cart-track leading into Old Rough Wood, three quarters of a mile east of Kirkby Station, and at Sandy Brow, south of Kirkby Moss. In the area hereabouts the Shirdley Hill Sand, which usually lies as an unfeatured sheet over the boulder-clay topography, rises into low ridges and hillocks elongated from W.N.W. to E.S.E. In places crescentic ridges have been seen, with their concavities to the west and convex outlines facing east.

In this area also a hard bed of iron cemented sand, an incipient pan, occurs at a depth of from one to two feet and varies in thickness from a streak to some eighteen inches. This pan, locally known as " pellet," is characteristic of the Shirdley Hill Sand area, and locally furnishes a useful means of separating the soils derived from the weathering of the Bunter Sandstone from those of Shirdley Hill Sand type. These two soils can be in many respects indistinguishable in certain areas ; and in fact, it can be said that except in the case of the well defined types, which are a minority, the soils of the district present such small differences to hand or eye that the light field auger now in use tends to become an indispensable aid to mapping.

Good sections of the Shirdley Hill Sand have been seen in the new Liverpool-Manchester road, and in a cutting west of the lodge at the north end of Knowsley Park, the peat which generally occurs at the base of the sands[1] was well exposed. This bed varies up to a foot in thickness, and even when it is absent a trace of the old soil layer on the boulder-clay can usually be seen.

Mr. Jones has surveyed the heavily mined district north and east of Wigan and southwards to the margin of the sheet. This district is mainly drift-covered and field work has been confined to the surface deposits which, in the southern part of the area, present several difficult problems. The mapping has been carried out with the auger and it has been found that fine sands, silts and clays occupy a considerable area in the south-east of the sheet. They are associated with frontal sands and gravels which, so far as is known at present, were laid down in a lake standing at about 130 ft. O.D. The ice-front which held up the waters of this lake extended from Newton-le-Willows north-west to Holland Lees and Parbold across the Douglas valley.

[1] Tonks, L. H., ' Summary of Progress ' for 1929, Part i (*Mem. Geol. Surv.*), 1930, p. 60.

In the extreme south-east corner of the map, sands at a lower level are present associated with silts and laminated clay, which may or may not belong to the 130-ft. lake.

Of the solid rocks mapped the most important is a hitherto unrecorded area of Manchester Marl (Permian), on the south margin of the Sheet, near Newton-le-Willows. The marls are faulted against Bunter Sandstone on the south-west by a north-west fault, and are overlain by the same sandstone. The structure appears to be anticlinal, and the discovery of this inlier makes probable a considerable extension of the coalfield. These fossiliferous marls were supposed to die out when followed from the Manchester area to the west, where Binney suggested[1] that the Lower Mottled Sandstone might be the equivalent of the Collyhurst Sandstone (Permian), a suggestion that has since been extensively adopted. It now appears that the marls extend much further west than was formerly known and that they are in all probability conformably overlapped to the north by the Bunter.

Mr. Mourant continued his training in the southern part of Sheet 75 (Preston) and mapped an area of Coal Measures and Triassic beds around Chorley. Considerable modifications of the former mapping have become possible here through the use of goniatites as zonal indices but no point of outstanding interest has arisen.

W. B. WRIGHT.

[1] *Trans. Manch. Geol. Soc.*, vol. ii, 1860, pp. 32-4.

5. CUMBRIAN DISTRICT

T. Eastwood, A.R.C.Sc., District Geologist.
F. M. Trotter, D.Sc.
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W. C. C. Rose, B.Sc.

DURING the year the memoir dealing with the Maryport district and the drift and solid editions of the one-inch map (Sheet 22) have been published. Sheet 18, Brampton, is in the hands of the printers and the memoir of that district is nearing completion.

Further progress has been made in the re-survey of the Cockermouth Sheet (23) by Messrs. Eastwood, Trotter and Hollingworth. Mr. Rose joined the unit in September and after a period of training under Dr. Trotter surveyed a few square miles to the south of Wigton.

Mr. Eastwood has been concerned in the mapping of the edge of the coalfield and the adjoining limestone series in the western part of the area ; Dr. Trotter was employed on somewhat similar measures around Caldbeck, while Mr. Hollingworth has continued his researches in the neighbourhood of Carrock Fell.

Skiddaw Slates.—Along the Caldew valley, above Mosedale, grey mudstones and black slates with interbedded grits belonging to this formation are arranged in closely packed folds trending approximately east and west. These rocks lie partly within the metamorphic aureole of the Skiddaw Granite ; to the north they abut—probably by a high angle thrust—against the igneous complex of Carrock Fell. West of that intrusion Skiddaw Slates, including much grit, form a flat-lying mass that appears to have been thrust north or north-eastwards on to the Borrowdale lavas around the headwaters of Roughton Gill.

The Carrock Fell Complex.—This mass of gabbro, granophyre and diabase,[1] some four miles in length by one in breadth, trends E.10°S.-W.10°N.

Several varieties of gabbro have been mapped in the principal outcrop on the southern side of Carrock Fell. These occur as lenticular masses that are parallel to the longer axis of the complex and dip south at high angles, being thus also parallel to the foliation and banding that is developed in certain types. Hybrid gabbros with pink acid patches and interstitial areas occur with normal gabbros near Roughton Gill mining works. Although intermediate types are found the varieties frequently maintain their distinctive characters up to their margins.

[1] The term used by Dr. A. Harker for the northern, finer-grained, basic portion of the complex, *see* ' Carrock Fell : a Study in the Variation of Igneous Rock Masses, Part I, The Gabbro,' *Quart. Journ. Geol. Soc.*, vol. i, 1894, pp. 312-337.

Within the granophyre, a basic variety showing sharp junctions against the normal rock has been mapped as a separate body. Veins of granophyre penetrate the gabbro but have not been noted in the diabase, against which, however, the granophyre locally develops a chilled margin. Elsewhere near the diabase the granophyre becomes rich in an acicular ferromagnesian mineral. There is usually a narrow zone of hybrid rocks between gabbro or granophyre produced *in situ* by the action of the latter on the former.[1]

Carboniferous Rocks.—In West Cumberland the main limestone group of the Lower Carboniferous comprises seven limestones (First to Seventh in descending order) separated by subsidiary shales and sandstones. When traced eastwards, however, across Sheet 23, this sequence is modified by the incoming and thickening of sandstones and shales which in particular affect the Fourth Limestone and split it into six main beds. These portions of the Fourth, together with the three succeeding limestones (Third to First of West Cumberland) and the associated detrital sediments, correspond so well with the Yoredale succession of the Cross Fell Escarpment, both in fauna and lithology, that the Escarpment names of the limestones are used by Dr. Trotter and will be adopted throughout Sheet 23. The lower measures are affected to a less extent and still consist mainly of limestone.

Shales at the base of the series near Blindcrake in the west have yielded various forms of lamellibranchs but the limestones in that region call for no special comment.

In the south-eastern part of the area near Berrier there is an upward sequence from the Seventh Limestone in a north-easterly direction as far as Gillcambon Beck, where a fault of north-north-easterly trend brings up the Borrowdale lavas. The highest part of the main mass of limestone hereabouts contains nodules with *Girvanella*. This bed is followed, as at Parsonby near Aspatria, by a thick shale.

In the Caldbeck area the beds between the Jew (=lower part of the Fourth) and the Great or First Limestone, exposed to the south of Warnell Fell and on Caldbeck Fell $3\frac{1}{2}$ miles to the west, possess many distinctive features which have aided identification in broken ground and in isolated exposures.

The Jew Limestone, in which *Saccamminopsis fusulinaformis* (M'Coy) [*Saccammina carteri* Brady] is very abundant, is also characterised by a pale semiporcellanous limestone near the base, in which there is a band with *Productus giganteus* (Mart.). *Caninia juddi* Thomson is common near the top, as was also the case in one of the quarries at Ward Hall between Aspatria and Cockermouth. The Tyne Bottom is a grey-blue, thinly-bedded limestone, some 40 ft. in thickness, with few fossils. The bottom bed, 2 ft. thick, is dolomitic. The Single Post Limestone is creamy white in colour

[1] Harker, A., *ibid.*

and in places is dolomitic. Where seen one mile east of Caldbeck the Cockleshell Limestone is 3 ft. thick and is underlain by a 12-in. coal, which recalls the double seam about that position at Ward Hall and at Broughton Craggs. Two massive posts, each 7 ft. thick, characterise the lower part of the Scar Limestone. They rest on a 2½-ft. bed which is rarely quarried and are overlain by 20 ft. of thinly-bedded limestone with shale.

Two thin limestones, separated by 10 ft. of calcareous shale yielding bryozoa and trilobites, represent the Five Yard Limestone, and here again we get close comparison with the top of the Fourth Limestone at Ward Hall.

The Three Yard and Four Fathom limestones, equivalent to the Third and Second limestones of West Cumberland, both contain chert in their upper portions, but the former is frequently pale grey or white and very crinoidal whereas the latter is darker and more compact.

The beds making up the Great Limestone vary little throughout the district. Usually there is 5 ft. of limestone divided by two shale partings, at the base, followed by two massive posts, each 10 ft. thick, and then 40 ft. of limestone in posts alternating with thin bands of shale. The faunal assemblage is also distinctive and includes *Aulophyllum fungites* (Flem.), mut. *pachyendothecum* S. Smith, *Dibunophyllum muirheadi* Nich. and Thom., and *Lonsdaleia floriformis* (Mart.), mut. *laticlava* S. Smith.

The rocks of the Hensingham Group over most of West Cumberland are subject to rapid lateral and vertical changes in lithology, but near Aspatria conditions of deposition evidently became more settled, for in that region it is possible to correlate beds met with in a boring not only with others penetrated near High Head, on the eastern edge of Sheet 23, but also with some of the rocks at the surface near Caldbeck and again with the sequence in the Brampton area. The Little Limestone and its associated coal, and the Firestone Sill, for instance, have been recognized. The coal, 18 to 20 in. thick, has been mined north-north-west of Caldbeck, on Warnell Fell and Denton Side and at Hewerhill farther east.

South of Aspatria the Gilcrux Fault, which in Sheet 22 (Maryport) forms the south-eastern boundary of the coalfield, takes on a more easterly trend and traverses lower measures, with the result that it now brings the Hensingham Group instead of the Coal Measures against various members of the main group of limestones. The latter as a rule dip between north and north-west, but there is evidence of some folding in addition to dip faulting. Although the precise horizon of some of these limestones is in doubt they are mainly of D1 age. In the Hensingham Group, north of the Gilcrux Fault, limestones are rare but sandstones are abundant and range from ganisters to limy freestones rich in brachiopods such as *Spirifer*, *Productus* and *Schellwienella*. Sharp folding is discernible in the group to the north and north-east of Torpenhow.

Faulting along north-west lines repeats some of the beds and causes the outcrop of the base of the Coal Measures to step backwards and forwards. Hereabouts the Yard Band is the lowest coal of consequence but the Three-quarter seams and the Albright near the bottom of the Productive Measures have been recognized.

Farther north, near Bolton New Houses, fossil-collecting by Mr. Hester has confirmed the existence of a marine band low in the Whitehaven Sandstone Series.

Red-stained Carboniferous rocks occupy a considerable area in the north-eastern part of Sheet 23 between Rosley, Sebergham and Middlesceugh. They are exposed in Chalk and Roe becks where they have yielded marine shells, Coal Measures plants and 'mussels,' but the exact relationship of these beds to the Coal Measures and the Hensingham Group is not yet known.

Triassic Rocks.—St. Bees Sandstone, with a little of the St. Bees Shales peeping out below, is thrown against the Coal Measures of the Bolton district by faulting. Exposures are limited to the neighbourhood of streams and to a few quarries but are sufficient to indicate that the structure is not a simple one.

Glacial.—Boulder-clays that represent two episodes in the glaciation of the district have been found in the valley of the Gillcambon Beck. The lower is a reddish clay with many fragments of Scottish granites, much Triassic and Carboniferous sandstone material and some Lake District stones. The higher boulder-clay is grey; Scottish and Triassic rocks are absent but Lakeland erratics and limestones of the Lower Carboniferous are abundant.

T. Eastwood.

6. NORTHUMBERLAND AND DURHAM DISTRICT

Headquarters : Newcastle-on-Tyne

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G. A. BURNETT, B.Sc., Senior Geologist.
A. FOWLER, M.A., B.Sc.
V. A. EYLES, B.Sc.
W. ANDERSON, M.Sc.
} Geologists.

DURING the past year field work in Northumberland continued on lines laid down in 1929. Much work was done on Lower Carboniferous rocks in one-inch Sheet 8, where Mr. Fowler was engaged in the North Tyne valley round Falstone, with Mr. Anderson working round Elsdon. The revision of the Coal Measures areas south of Morpeth (one-inch Sheet 14) was continued by Mr. Eyles, while in the autumn a start was made by Mr. Burnett in the coastal strip round Seaton Sluice : till that time he had been detained by office work over the forthcoming Cheviot memoir. In outside areas one or two bores and pit sinkings were examined, but coalfield developments in general showed a decided falling off compared with previous years.

Cementstone Group.—Near the mouth of the Southope Burn, above Ridlees, Mr. Anderson reports good sections showing purple and sandy shales of Cementstone age resting on an eroded and fissured surface of Old Red andesite. Local developments of the Group show the usual variegated shales and sandstones, but cement ribs are rare. The full thickness is about 1,000 ft. but north-east of Crigdon Hill faulting reduces this to less than 100 ft.

Fell Sandstone.—There are good exposures of this series along the high ridge from Crigdon Hill to Featherwood ; the upper beds are less coarse and false-bedded than in more eastern districts. A new quarry, 500 yds. W. of Ridlees Cairn, shows 15 ft. of fine-grained sandstone, in thin beds, evenly stratified. There are large boundary faults in this district, between which about 800 ft. of Fell Sandstone seems to be present.

Scremerston Coal Group.—As reported in last year's *Summary*, there is, in one-inch Sheet 8, much difficulty in fixing the upper limit of this group owing to the appearance of several marine limestones near the top of the series. In the typical areas to the north-east, true marine bands of any kind are extremely rare, and the junction with the overlying Limestone Group is taken at the Dun Limestone, the first below the Woodend. At present all the evidence is in favour of continuing that course in Sheet 8, so that the Redesdale, the Fourlaws and other limestones must, stratigraphically, be placed in the Scremerston measures, rather than, as hitherto, in

the Limestone Group. Mr. Anderson reports that at Wishaw, in the south-east corner of the Sheet, the first three limestones below the Woodend are all bluish crinoidal beds with *Girvanella* halos and Foraminifera: they are certainly above the Redesdale and Fourlaws positions. The Fourlaws Coal, said to be 2½ ft. thick, has been wrought in small faulted patches north-east of Otterburn and on Raylees Common. Below the Redesdale Limestone normal Scremerston conditions set in, and the usual thin coals and entomostracan beds are common. A seam has been wrought east of Pity Me, with a 'black bat' roof, and another, said to be 15 in. thick, on the banks of the Rede between Yearhaugh and The Peel. This latter seam is covered by 3 ft. of limy shale with *Fenestella* and well-preserved 'stick' Bryozoa.

In the Falstone district, Mr. Fowler found that good marine limestones begin to appear, even in strata below the Redesdale position. A typical example is seen at the foot of the Belling Burn, close to the North Tyne. A 6½-ft. bed of limestone outcrops here over a distance of 400 yds.: large *Producti*, *Lithostrotion*, crinoid debris and fenestellids abound. There is a very similar stone in the river east of Wellhaugh Moor, and further downstream are limy shales and grits rich in Bryozoa and Gasteropoda. The exact horizon of these limestones has still to be fixed, but they must at any rate be some way below the Plashetts Coal, the leading seam of the district. The chief workings in this coal, reached by a long drift in the hillside above Plashetts Station, are now under water, but another opening has been started close to the outcrop in the old Plashetts waggonway, where the seam is about 5 ft. thick. A new outcrop of the coal has recently been got about half a mile south of the Black Belling summit: this seems to be due to a hitherto unsuspected fault quite 300 ft. down south.

Several exposures of the Plashetts Dun and the Piper's Cross limestones have been examined: the latter is about 430 ft. above the Plashetts Coal and rests on a highly fossiliferous sandstone.

Limestone Group.—In a footnote on p. 63 of the Otterburn and Elsdon Memoir, Miller suggested that the Greenchesters Limestone, north-west of Otterburn, may be the equivalent of the Oxford Limestone of other districts. There can be little doubt that he was correct: not only is the limestone itself full of *Girvanella* nodules, but there is a coralline shale above, exactly as in the Raechester district, while below a further outcrop not far away (1 m. south-west of Davyshields) there are good exposures of one of the pale brecciated limestones usually found under the Oxford position. In the Otter Burn valley recognition of the strata between the Greenchesters and Redesdale limestones shows that this area must be crossed by several step-faults, down east-north-east, which have not hitherto been mapped.

Coal Measures and Permian.—In the short time available before the close of the field season, Mr. Burnett made a preliminary

investigation of the coast-sections round Seaton Sluice. Quarries of Magnesian Limestone are still open at the well-known Cullercoats inlier, faulted in by the Ninety-Fathom Dyke: they show sandy, unbedded and conglomeratic Middle Limestone resting unconformably on flat-bedded Lower Limestone. The underlying Yellow Sands are best seen on the shore, and are again faulted in at Collywell Bay, Seaton Sluice—the most northerly exposure known. A junction with Coal Measures was at one time seen here, but is now covered by a retaining wall necessitated by recurrent landslips.

Massive sandstones are the outstanding feature of the local coast sections. Amongst them are two well-known coals, the Yard—seen at low-water mark north of Seaton Burn, 2½ ft. thick, with another foot of coal 7½ ft. below—and the Low Main. Recent excavations show that the latter seam is, in all, 4½ ft. thick (coal 28 in., fireclay 6 in., coal 20 in.). Some way above there is a strongly-marked ' musselband,' well shown for nearly half a mile along the shore, and inland at an old day-level 500 yds. W. of Marden. Collections have been made from this band, together with others in the district, and the material is now under examination.

The Low Main ' musselband ' is well known in Northumberland and can be seen in the banks of the River Blyth above Hartford Bridge. About 2 ft. above it Mr. Eyles found a shale yielding fragments of *Belinurus*. He had previously got these fossils at a somewhat similar position in the Duke Pit, Ashington. These discoveries are of much interest, as they seem to be the first records of such arthropods in Northumberland: Mr. Pringle reports that the species is probably new.[1] ' Mussels ' were got here at several levels both above and below the coal, but the Low Main musselband itself is a hard, irony and platy bed, easily picked out from the rest.

A new pit sinking at Garmondsway, 5 miles south-east of Durham was examined by Mr. Burnett. Under 30 fathoms of Magnesian Limestone, a 50-in. coal was got here at 62 fathoms. If, as supposed, this is the Harvey seam, then the ' Hopkins Shell-bed ' above seems to be missing. Lower down the two Busty Coals proved to be, in all, no less than 8 ft. thick: they were separated by a 14-in. ' band.'

Mr. Fowler examined two experimental borings put down west of Woodside (Morpeth) to prove the lower coals. In the first, two seams were got, one a 31-in. coal taken to be the Brockwell and separated by 18 ft. of pebbly grit from a 40-in. bed of dirty coal, believed to be the Victoria seam. A second bore found a 30-in. coal above the Brockwell, so that a good coal reserve in this district seems to be assured.

Glacial.—A widespread sheet of boulder-clay from the western ice covers most of the country round Elsdon and in the North Tyne

[1] In Co. Durham *B. trechmanni* has been described ' from the highest Coal Measures of the Durham Coalfield, at Claxheugh on the Wear, near Sunderland.' *See* Woodward, Dr. H. ' Notes on some Fossil Arthropods from the Carboniferous rocks of Cape Breton, Nova Scotia,' *Geol. Mag.*, 1918, p. 469.

valley. Well-marked 'marginal channels,' associated with the retreat of the North Tyne glacier, are seen on the hillsides round Plashetts. There is a particularly good example 1 mile west of Falstone, with an intake south of Yarrow.

There are many good boulder-clay sections on the coast near St. Mary's Island. Both Upper and Lower clays are seen there, but at times the junction is very intimate, and the usual sand and gravel parting may be missing. Towards Morpeth Mr. Eyles has paid special attention to the laminated clays reported in last year's *Summary* as occurring between the two boulder-clays west of Sleekburn. In the surrounding country these deposits seem to be largely replaced by bedded sands, but they recur in the lower reaches of the Pont below Kirkley Mill. Here they lie 60 ft. higher than near Sleekburn, so that it seems difficult to believe that they were accumulated in the same sheet of water. The whole question as to the origin of these clays requires further investigation.

R. G. CARRUTHERS.

(B)—SCOTLAND

1. RENFREWSHIRE, LANARKSHIRE AND DUMFRIESSHIRE

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FIELD WORK was continued during the autumn by the above unit in two areas : in one-inch Sheet 30, south of Greenock, Renfrewshire, by Mr. Kennedy ; and in one-inch Sheet 15, in the Sanquhar coalfield, Dumfriesshire and near Crawfordjohn, Lanarkshire, by Messrs. Simpson, MacGregor and Ross. A re-investigation of the Carboniferous rocks of the Thornhill Basin, within the limits of one-inch Sheet 9, was carried out by Mr. Pringle and Mr. Richey.[1]

Renfrewshire

Calciferous Sandstone Volcanic Rocks.—A portion of the extensive outcrop of these rocks south of the Clyde estuary was mapped as far east as Kilmacolm and Bridge of Weir. The lava-sequence consists of an alternation of macroporphyritic basalts of Markle type and mugearites. These two types have frequently been observed by Mr. Kennedy in composite relationship, with Markle basalt invariably resting upon mugearite.[2] Near Kilmacolm, in Craigmarloch Wood and on the high ground south of the River Gryffe, interesting relations between mugearite and olivine-trachyandesite are seen. Both types are of lava-origin, to judge from exposures of brecciated bases overlying Markle basalt in both cases. But locally the trachyandesite is also found to follow the centre of the mugearite and to vein it intricately. At these places the trachyandesite contains partly resorbed xenoliths and schlieren of the mugearite.

Several dykes of mugearite and Markle basalt have been mapped. There are also a few Permo-Carboniferous E.-W. quartz-dolerite dykes. One of these, 60 ft. thick, is exposed in the Raventreehill Quarry at Kilmacolm, and has been traced for several miles.

Lanarkshire and Dumfriesshire

Lower Old Red Sandstone.—In the synclinal area of these rocks bordering the Southern Upland Fault, south of the Douglas

[1] *See* ' Summary of Progress ' for 1930, Part ii (*Mem. Geol. Surv.*), 1931.
[2] *See* ' Summary of Progress ' for 1929, Part i (*Mem. Geol. Surv.*), 1930, page 73.

coalfield, Mr. Ross finds that andesitic lavas occur at two horizons. The upper horizon is only developed in the southern limb of the syncline, next to the Southern Upland Fault, and is associated with lava-conglomerates. The conglomerates and also the sandstones consist largely of materials derived from the denudation of the lavas.

Carboniferous.—An outlier resting upon Ordovician greywackes on the south side of the Southern Upland Fault, near Whitecleuch, 4 miles S.W. of Crawfordjohn, includes Coal Measures in addition to beds already referred to the Calciferous Sandstone and Carboniferous Limestone Series. A musselband ironstone exposed on the east bank of the Duneaton Water has yielded to Mr. Ross specimens determined as *Carbonicola robusta* (J. de C. Sow.) by Mr. Pringle. This form is restricted to the lower part of the Productive Coal Measures. A coal formerly wrought south of the Duneaton Water is referred to the Limestone Coal Group, since it outcrops between a limestone of the Lower Limestone Group quarried at Craighead and the musselband.

In the Sanquhar coalfield, as is well known, Coal Measures rest unconformably upon the Ordovician. At the eastern end of the basin, however, beds referred to the Carboniferous Limestone Series intervene. These, Mr. MacGregor finds, are variable in character and include limestone in only two sections (near Muirhead and in the Bogs Burn). There appear to be no more than 50 ft. of strata between these limestones and the Ordovician greywackes. Fossils so far collected suggest that the beds belong to the Lower Limestone Group. Coarse sandstone almost immediately overlies the limestones or fossiliferous shales, as for example south of Auchentaggart Moor, 1½ miles E. of Sanquhar. Nearer to Sanquhar there is evidence from bores that the coarse sandstone directly overlies the Ordovician. It seems probable that this sandstone is of Upper Carboniferous age and corresponds to the unconformable grit (Millstone Grit) of Thornhill and the Douglas coalfield.[1]

Near the western end of the Sanquhar Basin a deposit similar to the Ayrshire Bauxitic Clay[2] has been located in three streams by Mr. Simpson. In the Polmarlach Burn, 50 yds. upstream from the New Cumnock-Sanquhar road, the deposit is 12 ft. thick. It varies from a typical hard clay with bluish kaolin veins to sandy clay. The horizon lies only a few feet above the Ordovician greywackes. It is not associated at Sanquhar, so far as is known, with Millstone Grit volcanic rocks. At the top of the Productive Coal Measures Mr. Simpson has noted Skipsey's Marine Band, at a sheepfold 400 yds. N. of Lagrae farm and again 150 yds. farther upstream.

Glacial.—In the neighbourhood of Crawfordjohn, Mr. Ross has studied the distribution of erratics of Spango granite and of the

[1] 'Summary of Progress' for 1930, Part ii (*Mem. Geol. Surv.*), 1931.
[2] The occurrence of a similar deposit in the Sanquhar coalfield has been previously noted: *see* Wilson, G. V., 'The Ayrshire Bauxitic Clay,' (*Mem. Geol. Surv.*), 1922, p. 24.

Crawfordjohn essexite. These testify to a north-easterly movement of the ice during the final period of glaciation.

West of Kirkconnel and south of the River Nith, near the Cairn farms, a number of overflow channels and gravel spreads have been mapped by Mr. Simpson. The channels in every case slope down towards the east, and supply further evidence of a westerly retreat of the ice previously demonstrated near New Cumnock.

J. E. Richey.

2. WEST HIGHLAND DISTRICT

J. E. Richey, M.C., B.A., District Geologist.
J. B. Simpson, B.Sc.
G. Ross, B.Sc.
A. G. MacGregor, M.C., B.Sc.
W. Q. Kennedy, B.Sc.
} Geologists.

FIELD WORK was re-commenced during the summer in the Ardnamurchan-Moidart district (one-inch Sheet 52). In Ardnamurchan, between Loch Sunart and Loch Shiel, Messrs. Simpson and Ross mapped the area from Ben Laga, where work was discontinued in 1922, eastwards to beyond Ben Resipol. Messrs. MacGregor and Kennedy surveyed a portion of Moidart, north of Loch Shiel, westwards of a line drawn from the eastern end of Glen Moidart to the vicinity of Dalelia.

In this area the sedimentary rocks consist of different types of Moine Schists. In the west the schists are affected solely by regional metamorphism but elsewhere they have undergone more or less intense injection metamorphism, resulting in the production of various types of injection-gneisses. In addition, intrusive igneous rocks of various types and ages are extremely numerous.

Moine Schists.—In Ardnamurchan and Moidart this series consists of belts of psammitic, semipelitic and pelitic schists striking approximately north and south. From the Carna Pelitic[1] eastwards to the western slopes of Ben Resipol psammitic schists predominate. A number of garnetiferous pelitic and semipelitic belts have been mapped, and are apparently infolded in the psammitic series. For example, a banded pelitic belt, extending southwards from near Acharacle, has been traced to within a mile of Loch Sunart, where it terminates. Two other belts, situated within the zone of granitic injection east of the road from Acharacle to Salen, end off northwards in a similar manner. North of Loch Moidart, a psammitic belt bounded by semipelitic terminates northwards. On Ben Laga and farther east, both north and south of Loch Shiel, quartz veins are abundant, and sometimes contain a little felspar and garnet.

Injection Complex.—An injection complex has been recognized both in Ardnamurchan and Moidart. The injection begins in force east of a line drawn from Salen on Loch Sunart to Kinlochmoidart House, and eastwards increases noticeably in intensity. It is especially obvious in a pelitic or semipelitic host. There is every variation between schists with pegmatitic or granitic strings and lenticles, lit-par-lit injection-gneisses and permeation-gneisses. Pegmatitic and granitic material occurs locally as cross-cutting veins

[1] Simpson, J. B., in ' Summary of Progress ' for 1921 (*Mem. Geol. Surv.*), 1922, p. 89.

and concordant intrusions, either sheets or lenticles. Such intrusions are frequently seen to invade the adjacent schists along the foliation and to form typical injection-gneisses. The majority of the gneisses so far examined contain oligoclase as their felspathic component, and the grain of the rocks is much coarser than that of the non-injected rocks to the west. In some cases potash felspar is abundant. In certain areas, as for example east of Dalelia, muscovite is the most characteristic mineral, and often forms porphyroblasts, especially in a semipelitic host. Rocks containing large augen of muscovite are associated with sillimanite-gneisses. Typical rocks of the injection-zone are garnetiferous muscovite-biotite-gneisses. Staurolite is sometimes present and sillimanite locally abundant. Tourmaline occurs in pegmatites and adjacent gneisses.

The injection complex has been examined at different points along the margin of the Strontian granite, near Bellsgrove Lodge and Woodend Cottage on Loch Sunart. At these places the injection is intense, and the gneisses show remarkable features suggestive of rock-flowage. Pronounced disruption and de-orientation have resulted in the formation of eruptive breccias resembling those illustrated by Sederholm.[1] The relation of the Strontian granite to the injection complex has not yet been studied in detail. It may be significant that the injection decreases rapidly in intensity westwards from the granite-margin along the northern shore of Loch Sunart.

Minor Intrusions.—Sheets and subordinate dykes of lamprophyre and coarser-grained rocks allied to the appinites of the Glen Coe district[2] are often abundant, particularly in the neighbourhood of Glen Moidart. The lamprophyres resemble some of the luciites and orbites of the Odenwald. A few broad W.N.W. dykes occur north of Loch Moidart, and are cut by Tertiary dykes. They are decomposed pink porphyritic rocks resembling spessartite, and are therefore presumably of Lower Old Red Sandstone age. Broad dykes and elongated bosses of quartz-dolerite extending east and west are a general feature of the area surveyed, and resemble the Permo-Carboniferous suite. Both dykes and bosses are sometimes crowded with xenoliths of quartzite. They have effected intense contact-alteration in the adjoining schists, and spinel-bearing hornfelses have been developed. Dykes of camptonite and monchiquite, running east and west, are frequent. These in some cases are associated with lead-bearing veins. Tertiary dykes, N.-S. to N.N.W.-S.S.E. in direction, 20-30 ft. broad, are especially abundant in Moidart north of Acharacle ; many of these are felspar-phyric dolerites of tholeiitic affinities.

J. E. RICHEY.

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[1] Sederholm, J. J., ' Om Granit och Gneiss,' *Bull. de la Commission Géologique de Finlande*, No. 23, 1927, Plates i-viii.

[2] Bailey, E. B., in ' The Geology of Ben Nevis and Glen Coe ' (*Mem. Geol. Surv.*), 1916, pp. 167-168.

3. SHETLAND

G. V. Wilson, B.Sc., District Geologist.
H. H. Read, D.Sc., A.R.C.Sc. } Senior Geologists.
J. Phemister, M.A., D.Sc. }
D. Haldane, B.Sc. }
J. K. Allan, M.A., B.Sc. } Geologists.
J. Knox, B.Sc. }

FIELD WORK in Shetland was continued during the past season by the above-named members of the staff. Dr. Read and Dr. Phemister completed the work commenced by them last year in Unst and Fetlar. Progress was made by Mr. Haldane in the district between Lunnasting and Olna Firth, by Mr. Allan in Yell and by Mr. Knox in the area between Quarff and Sandwick. A small area was started by Mr. Wilson at Scalloway.

During his tour of inspection the Director, Sir John S. Flett,[1] was successful in re-discovering, at the Voe of Cullingsburgh in Bressay, the outcrop of the bed with fish-remains that was found by him some thirty years ago. The locality has since been collected by Mr. R. Eckford, but so far the results obtained have added little to our previous knowledge of the fauna of the bed. A careful examination of the rocks exposed in the neighbourhood has, however, revealed the presence of what is either another exposure of the band, or the outcrop of a separate fish bed.

Unst

Metamorphic Rocks.—The survey of Unst has been completed by Dr. Read who has supplied the following summary of his results.

From west to east the island is made up of the rock-groups listed below and shown in Figure 1.

1. The Westing Group of striped hornblendic rocks, calc-silicate-rocks and felspar-blebbed gneisses with a thick calcareous horizon at its upper limit.
2. The Valla Field Group of staurolite-garnet-kyanite-gneisses.
3. The Burra Firth Group of siliceous and felspathic granulites and garnet-tourmaline-gneisses.
4. The Saxa Vord Group of chloritoid-kyanite-schists.
5. The Norwick Group of hornblendic and graphitic schists and phyllites, possibly including the Loch of Cliff Limestone.
6. The Main Serpentine, with pyroxene-rock towards its top.
7. The Main Greenstone.
8. The Muness Group of phyllites with thin belts of conglomerate-schist.
9. Mu Ness Serpentine and Greenstone.
10. The Augen-granite of Skaw.

[1] Flett, Sir John S., 'On the Age of the Old Red Sandstone of Shetland,' *Trans. Roy. Soc., Edin.*, vol. xlvi, 1908, pp. 315-316.

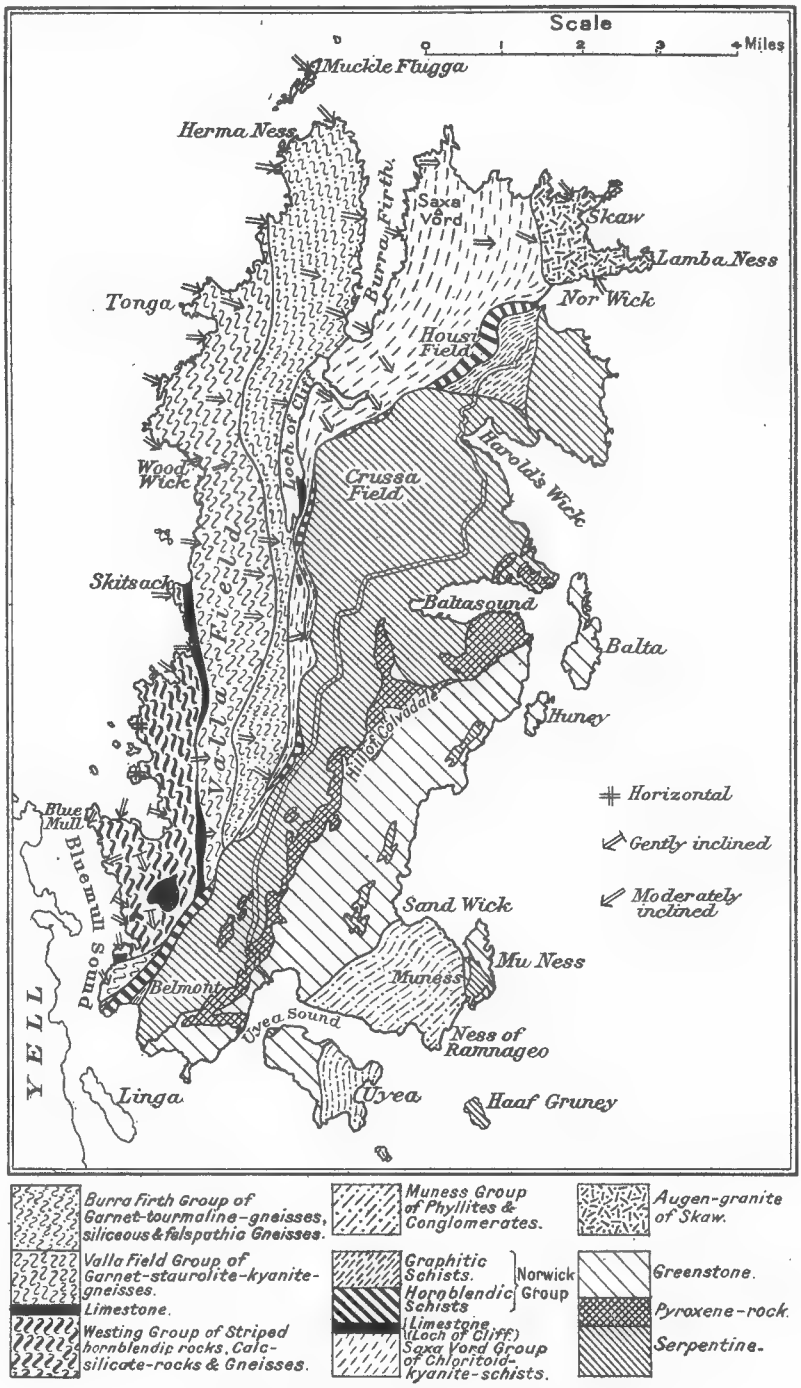

FIG. 1.—*Geological map of Unst, Shetland Islands.*

The Westing Group forms the diversified ground in the Westing and Lund districts. It consists of pelitic gneisses with conspicuous felspar blebs, streaky garnetiferous muscovite-biotite-gneisses, striped hornblendic epidotic and quartzo-felspathic granulites and schists, calc-silicate-rocks and fairly pure limestones. Over the western portion of its outcrop the group is almost horizontal or inclined towards the west, but farther east a regular dip to the east or south-east is encountered, the group thus passing below the succeeding Valla Field gneisses. The limestone forming the uppermost portion of the Westing Group is seen at Hagdales Nest and runs southwards at the base of the great Valla Field scarp to the Loch of Stourhoull where, as explained below, it is possibly cut out by a great thrust. The limestone seen on the coast half a mile north-north-west of Belmont may be interpreted as a reappearance of the main limestone due to the change of strike observed in this quarter. Around Snabrough, 1¾ miles north of Belmont, limestone lies fairly flatly upon felspar-blebbed gneisses; these outcrops may be considered to be outliers of the main limestone.

The Valla Field gneisses form the high western ridge of Unst. The structurally-lowest members following upon the Westing Group are very coarse biotite-gneisses with quartzo-felspathic folia. These rocks are threaded with much acid igneous material and recall sillimanite-bearing permeation-gneisses of injection-complexes. In this belt are found innumerable layers, lenses or small irregular bodies of coarse hornblende-schist which often form a heterogeneous melange, well seen in the cliffs between Wood Wick and Tonga. These rocks are succeeded by a great development of coarse garnet-staurolite-kyanite-gneisses, in which staurolite and kyanite often exceed several inches in size. A small area of gneisses referred to the Valla Field Group is found north-west of Belmont above the limestone of that district.

East of the gneisses just described comes the Burra Firth Group which makes the promontory of Herma Ness and the eastern slopes of Valla Field. It consists of siliceous and felspathic flaggy gneisses and granulites, with subordinate intercalations of pelitic gneiss containing garnet and tourmaline in abundance. At Herma Ness belts of hornblendic rocks are seen in the cliff-sections, whilst at Looss Wick, immediately east of Herma Ness, a limestone 20-30 ft. thick has been noted. The Burra Firth Group cannot be followed much farther south than Loch of Watlee where, as in the case of the Valla Field and Westing groups, it runs against great thrusts.

At many localities in the three groups of gneisses so far described there occur small masses of serpentine surrounded in order by zones of talc-rock, actinolite-rock and coal-black mica.

Chloritoid has been noted in the southern portions of the outcrops of the Westing and Valla Field gneisses, as, for instance, on the coast west of Belmont and at Snarra Voe north of Belmont. Further, these gneisses show, as they are followed from north to south, the gradual oncoming of a diaphthoretic metamorphism with

the production of chloritic and sericitic schists. Moreover, these diaphthoretic gneisses appear to be still further broken down in the vicinity of the thrusts believed to have traversed the south-western portion of the island. It is possible that here the gneisses have undergone at least three metamorphisms of varying physical characters.

The Saxa Vord Group builds the high hills on the east side of Burra Firth. The chief rock-type is a dark grey chloritoid-kyanite-schist, with subordinate bands of flaggy quartzo-felspathic rocks. Garnet and staurolite are common, but these minerals appear to be relict from an earlier metamorphism than that which produced the chloritoid assemblage. The group is cut by thick massive quartz veins containing large rosettes of kyanite.

The Saxa Vord Group is succeeded by a series of hornblendic, graphitic and micaceous phyllites and schists best seen at Norwick. Smaller developments appear at intervals from below the Main Serpentine, as at Loch of Cliff, due west of Baltasound and at Loch of Watlee. Around Belmont a comparatively large outcrop of this group is found between the Valla Field gneisses and the Main Serpentine. The thick fine-grained limestone of Loch of Cliff is probably to be included in the Norwick Group.

The Main Serpentine covers some 16 square miles. The intrusion originally consisted of a basal peridotitic portion and an upper pyroxenitic part, but it has been modified in various ways to produce many varieties of serpentine, talcose-serpentine, talc-rocks and tremolitic rocks. Along its base occurs a thick zone of talcose rocks, especially well developed at Queyhouse near Loch of Cliff. The mass of serpentine forming the great headland between Harold's Wick and Nor Wick appears to be separated by thrusting from the main body lying to the south, for the variation and structure of this mass are clearly related to the margin shown in Figure 1.

The Main Greenstone follows to the east of the Main Serpentine. The junction between the two is often a sheared one but enough natural margins are seen to show that the greenstone is the later intrusion. It consists of a pale-coloured greenstone often passing in belts of shear into green schist. Very coarse-grained patches are abundant, whilst on Balta and elsewhere pegmatites composed of great crystals of hornblende and felspar are well developed. On a horizon that can be traced from Balta by Longa Water and Sandwick to Uyeasound and the island of Uyea there are found large bodies of serpentine and related ultrabasic rocks. These may be provisionally interpreted as included masses.

The Muness Group consists of grey-green or dark phyllites with a well-expressed rodded or ' woody ' structure. At Ness of Ramnageo there is a belt, about 100 ft. thick, of coarse conglomerate-schist with pebbles of granitic rocks, quartzite, greenstone, etc. Similar phyllites and conglomerate-schists occur on the eastern part of the island of Uyea. Quartz veins are abundant but, like the

associated phyllites, show no development of metamorphic minerals of high grade.

The promontory of Mu Ness consists of a coarse usually massive greenstone lying below a serpentine, the folded junction between the two being well seen in the sea-cliff immediately south of Mu Ness. This superposition of serpentine on greenstone is the opposite relation to that of the Main Serpentine and Greenstone.

The augen-granite of Skaw forms the north-eastern part of Unst. The rock is a uniform augen-granite with crystals of red orthoclase up to 3 inches in length set in a granulitic base of quartz and micas. It is quite unlike augen-gneisses associated with injection processes. It encloses large xenolithic masses of sedimentary origin, mostly siliceous granulites. Certain of these show sporadic porphyroblasts of felspar similar to that of the igneous rock. The western margin of the augen-granite where the rock is seen to overlie the Saxa Vord Group is a thrust, below which the sediments are much contorted, whilst, along the junction, the igneous rock itself has undergone considerable deformation.

Basic sills and dykes of spessartitic character, often with sheared margins, are extremely abundant in the Westing and Valla Field groups, in the augen-granite of Skaw, in the Muness phyllites and in other groups. At Nor Wick a large intrusion of a dioritic type of rock has been noted.

From the distribution of the rock-groups and the characters of the junctions it is exceedingly probable that thrusting is one of the main factors in Unst tectonics. Possibly the margins between the Main Serpentine and Greenstone are the only natural ones in the island. The three gneiss groups of the west are in juxtaposition in turn, at the southern terminations of their outcrops north of Belmont, with various members of the Norwick Group. On the coast west-south-west from Belmont the junction between the detached area of Valla Field gneisses and the phyllites of the Norwick Group is a dislocation marked by a belt of brecciation and crushing some 30-40 yds. across. Northwards from Belmont to Loch of Cliff the junction between gneisses of the Burra Firth Group and the rocks lying to the east is marked by the great central hollow of Unst, which is continued still farther north by Burra Firth. In this hollow various beds of the Norwick or Saxa Vord groups are found adjacent to the western gneisses. Attention may be directed to the markedly lenticular habit of the Loch of Cliff Limestone and of small bodies of graphitic schists, not shown on Figure 1, when against this junction. The characters of the bases of the Skaw augen-granite and of the serpentine between Nor Wick and Harold's Wick have already been mentioned. The base of the Main Serpentine is marked by great shearing all along its outcrop. The serpentine rests in turn upon graphitic schists of the Norwick Group, hornblendic schists of the same group, flags and schists of the Saxa Vord Group, gneisses of the Burra Firth Group and even of the Valla Field Group—the underlying rocks in all cases being intensely sheared and crushed near the

boundary-line. Finally, the margins of the Muness phyllites with the Main Greenstone on the west and the Mu Ness Greenstone on the east are marked by shearing and brecciation. It is concluded, therefore, that the structure of Unst is the result of thrusting movements from the east which have operated upon rock-groups of markedly different physical characters. During this thrusting certain homogeneous massive rocks have moved as a whole but others, especially limestone, hornblendic and graphitic schists, have been sheared out into small lens-shaped bodies.

Fetlar

Along the west coast of Fetlar from Cluster to the Dale of Oddsta Dr. Phemister finds that the Lambhoga Group consists of flaggy siliceous and scaly chlorite-muscovite-schists, with which are locally interbanded chloritic schists and flaky pink schists composed of muscovite with black spots of tourmaline. The eastern part of the Lambhoga Group from the beach at Tresta northwards to the main road consists of siliceous gneiss often with small felspar augen.

The eastern boundary of the group is a series of lines of dislocation against which the serpentine and phyllites of the Central Group end abruptly. One dislocation is exposed at the Dale of Oddsta where granulated siliceous schist dips south-westwards at 45 degrees off a crushed green material that has probably been a phyllite. Between Urie and the Wick of Gruting, the Central Group consisting of phyllites, conglomeratic epischists, black schists, serpentine and greenstone, is folded into two synclines and an anticline. The western syncline is occupied by green phyllites and the eastern by the serpentine of Vord Hill. The anticline between is well exposed on the shore north of Stackaberg. These structures are complicated by lines of movement ; for instance on Stackaberg the Vord Serpentine, with greenstone in places below, overrides the sedimentary part of the group on a flat thrust. A small window of steeply dipping black and green schists is exposed in the centre of the outcrop of serpentine and greenstone (Fig. 2).

The Main Serpentine of Fetlar occupies the Vord Hill. It is an ochreous weathering rock, generally with abundant pale greenish-yellow prisms of bastite. Variations in the proportion of those crystals leads on the one hand to a rough weathering rock, and on the other to a smooth weathering dark green or brown homogeneous dunite serpentine. A distinct reddish or whitish weathering variety which shows a translucent green colour on broken surface is persistent along the base of the Vord Serpentine. Another variety of dunite serpentine, frequently banded and weathering with a thin irony skin, outcrops along the east side of Hamara Field, and on the east of Stackaberg. In both localities it separates the main serpentine from the underlying greenstone. Associated with it is a pyroxene-rock similar to that noted by Dr. Read between the serpentine and greenstone in Unst.

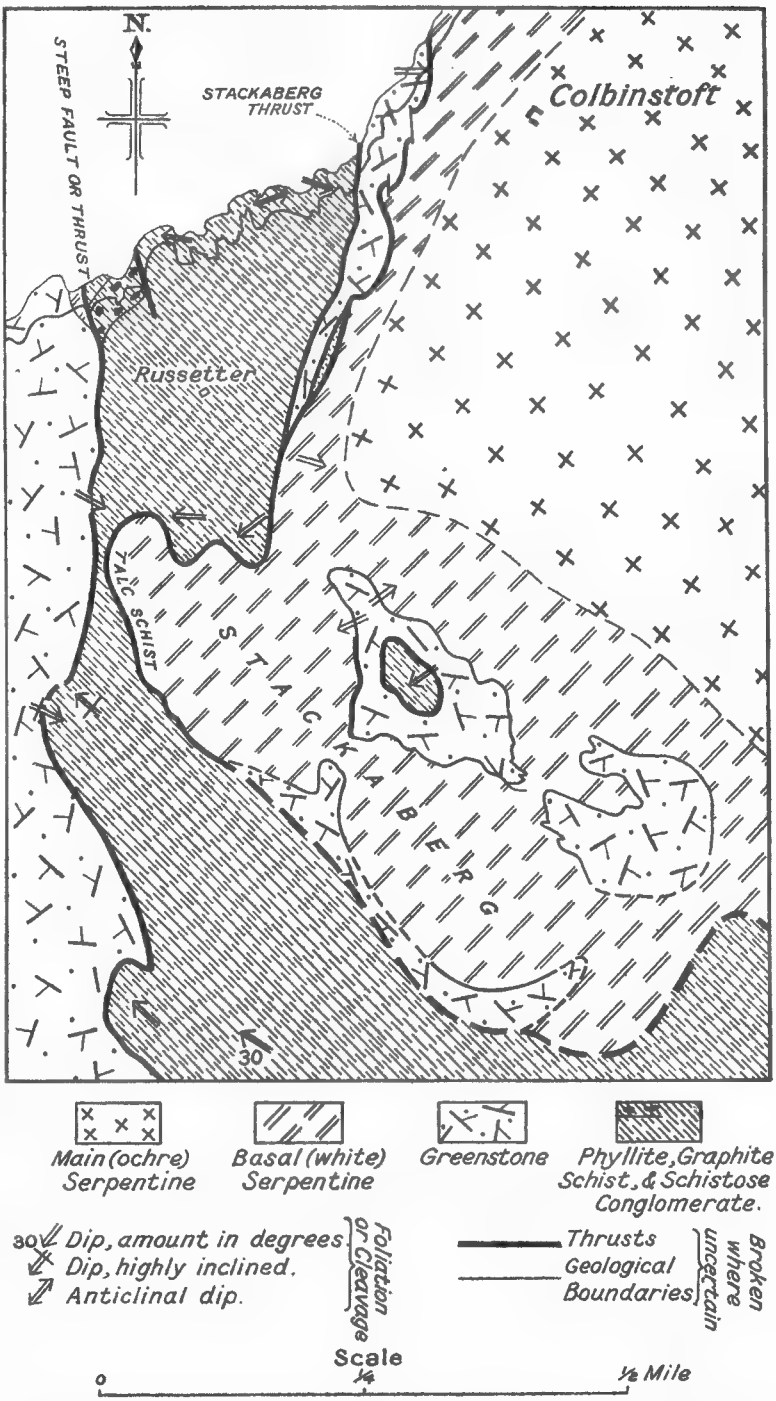

FIG. 2.—*Sketch-map of the Stackaberg Thrust, Fetlar, Shetland.*

The islands of Haaf Gruney and Sound Gruney are made of serpentine, and Daaey and Urie Lingey of greenstone. A thin band of conglomeratic green schist outcrops on the south end of Urie Lingey, and a similar rock is seen in the skerry of Stongir Holm north of Urie Ness. Green phyllites form the eastern half of Uyea and Wedder Holm. At Tur Ness they include conglomerate schist, and on the coast south of the Hall two thin ochreous weathering blue limestones occur in the series. The western half of Uyea is occupied by speckled greenstone with rare masses of serpentine, and is a southern continuation of the belt of rocks of this type that occur across the Sound in Unst.

Lunnasting and Voe

In the ground surveyed by Mr. Haldane the various rock-types include gneisses, schists and limestones, together with intrusions of granitic rocks (sometimes slightly sheared), pegmatite veins and numerous dyke-like irregular masses of basic and lamprophyric rocks. The dip is towards the west and north-west, and the amount gradually increases westwards until in the ground between Laxo and Voe the beds are often vertical. In the southern part of the area the strike is almost north and south, but it veers round and becomes north-east when traced into Lunna Ness.

The gneisses, which are most prevalent in the east, consist of coarse biotite, and muscovite rocks with abundant felspars and quartz, and accessory garnet. Included in the group are prevalent bands of garnet-hornblende-schist. The appearance of much of the rock seems to indicate that it was formed by the injection of a pre-existing sedimentary schistose series by a granitic magna. At Stofast in Lunna Ness, and at Grunna Voe to the north of Vidlin masses of coarse augen-gneiss were noted. In the Lunning district and also on the West Kame to the south-south-west of Voe gneisses occur containing tourmaline and staurolite.

The structurally overlying schistose group consists largely of siliceous granulites with numerous bands of hornblendic and micaceous schists with garnets. Phyllites are met with to the south-east of Laxo. The nature of the junction between this group and the main body of gneisses is obscure.

Bands of limestone up to 25 ft. in thickness are prevalent in both the gneissose and schistose groups. The main band, however, is associated with the schists. It forms an outcrop that is about a quarter of a mile wide and extends from Dales Voe in Delting to Voe, and then continues southwards through Weisdale.

Yell

Mr. Allan finds the rocks exposed in North Neaps and Houlland to be the northerly extensions of the outcrops of garnet-biotite-

gneisses and siliceous schists of the central part of the island. On the east these rocks are bounded by a belt of striped hornblendic schists and gneisses that are well seen in the headlands of Papil, Cullivoe and Grimsetter. The field relations between the two groups are obscure, but it is possible that a line of shear extends from Migga Head by Loch Papil, Culli Voe and Grimsetter to the Head of Gutcher. In the vicinity of this line occur numerous green basic dykes and small sills that are much sheared and broken, but otherwise unaltered.

The series of siliceous schists seen at Kaywick and Hevdigarth has been traced southwards from Mid Yell Voe into the hills of Lussetter and Vatsie. Westwards these schists pass upwards into fine-grained semipelitic rocks, with lenticular belts, and one thick band of quartzite. The latter forms the high ridge of Reafirth Hill. The succeeding rocks, which extend as far as the burn of Buster are garnetiferous gneisses of similar types to those found near the Lochs of Lumbister.

Traces of severely folded and sheared striped hornblendic rocks occur along the west shore of Whale Firth. They lie along a line of movement and are followed on the west by a thick series of lenticular silvery siliceous schists which, dipping steeply seawards, form the high cliffs between Stany and Rulkies hills.

Quarff and Sandwick

Except for a narrow discontinuous strip of strata of Old Red Sandstone age along the east coast, the area examined by Mr. Knox is occupied by metamorphic rocks. These are for the most part inclined at high angles to the east. Starting from the west side rather more than half of the peninsula is found to consist of a wide belt of grey slaty phyllites with subordinate grits and siliceous phyllites, together with white quartz veins. Towards the eastern margin of the belt the foliation becomes irregular and planes of shear are frequent. Still farther east there follows a varied series of dominantly argillaceous rocks including chloritoid schists together with limestones, calc-silicate rocks, black amphibole rocks and graphitic schists. Large masses of serpentine and talc schist, well seen on the eastern slope of Hoo Field, also occur. These masses are bounded by planes of shear along which they wedge out, as is seen at Lamba Taing, south of Clifts. Numerous small bosses of basic igneous rock penetrate the serpentine and talc but are rare in the sedimentary series.

Old Red Sandstone.—Mr. Knox finds that the unconformity between the basal breccia of the Old Red Sandstone and the underlying schistose rocks is seen at several localities between Quarff and Okraquoy. Southwards from Okraquoy the coast shows a con-

tinuous section upwards from the breccia into the overlying Brindister Flags, as far as Aithwick. The outcrop is there interrupted by the continuation of the main boundary fault, which cuts across to Aith Voe, reappears again on the coast about three quarters of a mile north of Sand Lodge, and extends south-west to Hoswick. The area to the east of the fault, including the island of Mousa, is composed entirely of Brindister Flags, with the exception of a small faulted area of phyllites that occurs on the coast about 200 yds. south of Sand Lodge. A band of limy flags, that as yet has not yielded any fossil remains, has been traced from north to south across Mousa.

G. V. WILSON.

III. SECTIONAL REPORTS

1. PALAEONTOLOGICAL DEPARTMENT

In London

F. L. KITCHIN, Sc.D., Ph.D., F.R.S., Palaeontologist (District Geologist).
C. P. CHATWIN, M.Sc., Assistant-Palaeontologist (Senior Geologist).
C. J. STUBBLEFIELD, Ph.D., A.R.C.Sc., Geologist.

In Edinburgh

J. PRINGLE, Assistant-Palaeontologist (Senior Geologist).

A. ENGLAND AND WALES

The general course of the year's work in this Department has been outlined above, in the Report of the Director (p. 26). Attention may here be directed to a few results of interest that have been attained during the progress of work.

Early in the year some fragmentary fossils discovered by Mr. H. G. Dines in pieces of ferruginous sandstone found near the surface at Rothamsted, Hertfordshire, and suspected by him to be of Pliocene age, were sent to the Palaeontological Department for examination. Mr. Chatwin superintended an excavation, made by permission of Sir John Russell, for the purpose of exploring the extent and mode of occurrence of the sandstone, and examined the fossils collected from it by Messrs. S. W. Hester and W. Dewar, determining them to be of Pliocene (Red Crag) age. The results of his examination were published in the *Summary of Progress* for 1929, Part III, 1930 (p. 2). A model of the excavation made to scale in the Palaeontological Department by Mr. S. W. Morgan, showing that the sandstone occurred as isolated blocks, was exhibited at the Conversazione of the Geologists' Association in November, 1930. Further work on Pliocene material done by Mr. Chatwin includes the preparation of an exhibit in the Museum, showing fossils of that age from Rothamsted (Hertfordshire), Netley Heath (Surrey), and Lenham (Kent), and illustrating these specimens, which are preserved as either moulds or casts, by means of wax impressions.

Amongst the materials collected by Mr. W. D. Ware of Ystradgynlais from the Coal Measures passed through in the shaft sinkings at Cefn Coed, near Neath, Dr. Stubblefield has identified *Prothyris* aff. *elegans* Meek, and pygidia of *Griffithides* cf. *scitula* Meek and Worthen. These come from the horizon of *Anthracoceras aegiranum* H. Schmidt, the Lower Marine Band at Cefn Coed. This

level, which Prof. A. E. Trueman considers as occurring within the Zone of *Anthracomya pulchra*, is the highest horizon in Britain from which trilobites have yet been recorded. Their association there with rugose corals, soon to be described by Dr. Stanley Smith, is of great interest.

In the course of naming fossils from the Millstone Grit of Yorkshire and South Wales, Dr. Stubblefield has found specimens of an undescribed *Aviculopecten*, referred to provisionally in lists as *Aviculopecten* cf. *losseni* (von Koenen). This form is associated with *Gastrioceras cumbriense* Bisat and *G. crenulatum* Bisat in collections made by Mr. W. Dewar near Meltham, Yorkshire (Sheet 86), and it occurs along with *Gastrioceras* cf. *cumbriense* in material collected by Dr. T. Robertson near Pen-y-cae, Breconshire (Sheet 231). The association of this new species of *Aviculopecten* with the fauna of the *Gastrioceras cumbriense* Zone has already been noticed in Lancashire and Cumberland by Dr. J. W. Jackson.[1]

Since 1927, Dr. E. S. Cobbold has been examining Lower and Middle Cambrian fossils collected from the neighbourhood of Rushton, in Sheet 152 (Shrewsbury). Preliminary notes of the stratigraphical succession have already been published[2] and Dr. Cobbold's determinations of Survey material are now almost completed ; his own collection from the exposures still requires examination. From the shales on the east flank of Charlton Hill a rather well represented fauna has been recovered, which includes specimens of an *Acrothele* of the type found by G. F. Matthew in the lower division of his Etcheminian and below the *Protolenus* Fauna of eastern North America. With these are also found several of Matthew's genera of branchiopod crustaceans, such as *Bradoria* (*Bradorona*) and *Indiana ?*. It seems to Dr. Cobbold to be highly probable that Matthew's Etcheminian Series is a shale formation, of Mesonacidian age in its lower part and running up into Paradoxidian age at the summit.

In 1928 an account was published of the section shown in the Ruabon Marl (Upper Coal Measures) in the New Pit at Hafod Brickworks, Johnstown, Wrexham,[3] in which there occur thin bands of limestone, some containing *Spirorbis* and fish-remains. At that time no collection of fossils from these bands was available for study. During the course of 1930 two small collections of fish-remains from a *Spirorbis*-limestone in this pit were submitted by Mr. E. D. Nicholson, F.G.S., and Mr. H. H. Simpson, B.Sc., respectively, for examination. Most conspicuous among these remains were spines and spine-fragments of *Gyracanthus*. The specimens were examined by Prof. D. M. S. Watson, who referred one spine-fragment with some doubt to *Gyracanthus formosus* Agassiz. Other spines of rather different character could only be referred by him to *Gyracanthus spp.*, while portions of plates also represented the same genus. Other

1 'Problems in the Classification of the Carboniferous Rocks,' President's Address, *Journ. Manch. Geol. Assoc.*, vol. i, pt. 2, 1929, p. 72.

2 'Summary of Progress' for 1927, Part i (*Mem. Geol. Surv.*), 1928, pp. 40, 41.

3 'The Geology of the Country around Wrexham,' Part ii (*Mem. Geol. Surv.*), 1928, pp. 103, 104.

fragmentary remains, including portions of a skull and lower jaw, and various scales, were referable to *Megalichthys*.

In continuing his work on samples from the Lower Chalk of the Reigate area, Mr. A. G. Davis has prepared a further series of slides of named Foraminifera and Ostracoda from the Varians Zone of Merstham, and has presented them to the Geological Survey.

The following specimens in the Museum have been figured, described or mentioned in publications :—

IN THE PALAEONTOGRAPHICAL SOCIETY'S VOLUME FOR THE YEAR 1928.

(Published 1930).

A Monograph of the British Palaeozoic Asterozoa. (Part viii).

By DR. W. K. SPENCER, M.A., F.G.S.

Calyptactis spinosus *Spencer*, pl. xxv, fig. 7, p. 396 ; text-fig. 254, 256, 257, pp. 395-397.
Aulactis orthopeda (*Salter MS.*) *Spencer*, pl. xxviii, fig. 9.
Encrinaster hamlingi *Spencer*, text-fig. 274, p. 426 (5 specimens).
Urosoma hirudo (*Forbes*), p. 434 (5 specimens).

A Monograph of the Ammonoidea of the Gault. (Part vii).

By DR. L. F. SPATH, F.G.S.

Euhoplites vulgaris *Spath*, pl. xxvi, fig. 4c, p. 294.
,, boloniensis *Spath*, text-fig. 98c, p. 296.

A Monograph of British Corallian Lamellibranchia. (Part ii).

By DR. W. J. ARKELL, M.A., B.Sc., F.G.S.

Trigonia hudlestoni *Lycett*, pl. v, fig. 2, p. 73.
,, triquetra *Seebach*, pl. v, fig. 3, p. 74 ; text-fig. 13, p. 75.
,, pickeringensis *Arkell*, pl. v, figs. 4, 4a, 5, p. 76 (2 specimens).
,, blakei *Hudleston*, p. 78.
,, spinifera *d'Orbigny*, p. 81 (2 specimens).
Camptonectes rigidus (*J. Sowerby*), pp. 96-98.
,, lens (*J. Sowerby*), p. 96.
,, woodwardi (*Morris and Lycett*), p. 98.

IN THE QUARTERLY JOURNAL OF THE GEOLOGICAL SOCIETY, VOLUME LXXXVI.

Fossil Insects of the South Wales Coalfield.

By DR. H. BOLTON, F.R.S.E., F.G.S.

Archimylacris sp. (pronotum of), pl. iii, fig. 2, p. 21.
Soomylacris strahani *Bolton*, pl. iii, fig. 5, p. 25 ; text-fig. 7, p. 26.

The Avonian Succession in the South of the Isle of Man.

By MR. H. P. LEWIS, M.A., F.G.S.

Zaphrentis enniskilleni enniskilleni *Edwards and Haime*, emended, pp. 277, 279.

Some Valentian Corals from Shropshire and Montgomeryshire, with a Note on a New Stromatoporoid.

By Dr. Stanley Smith, M.A., F.G.S.

Acanthocyclus binus (*Lonsdale*), pl. xxvi, fig. 1, p. 294 (3 specimens).
Calostylis roemeri *S. Smith*, pl. xxvi, figs. 2, 3, p. 296 ; text-fig. 1, p. 295 (12 specimens and 8 micro.-slides).
,, togata *S. Smith*, pl. xxvi, figs. 4, 5, p. 296 (3 specimens and micro.-slide).
,, intermediate in character between *togata* and *roemeri*, p. 297.
,, aberrans *S. Smith*, pl. xxvi, figs. 6-8, p. 297 ; text-fig. 1, p. 295 (7 specimens and micro.-slide).
Cantrillia prisca *S. Smith*, pl. xxvi, figs. 9-19, p. 298 ; text-fig. 2 (6 micro.-slides), p. 299 (19 specimens and 7 micro.-slides).
Cystiphyllum cylindricum *Lonsdale*, p. 300 (3 specimens and 2 micro.-slides).
Petrozium dewari *S. Smith*, pl. xxvi, figs. 20-28, p. 307 (8 specimens and 9 micro.-slides).
Phaulactis angusta (*Lonsdale*), p. 308.
,, *near* angusta (*Lonsdale*), pl. xxvii, figs. 1-8 ; text-fig. 6, p. 309 (3 specimens and 8 micro.-slides).
,, sp., pl. xxvii, figs. 9-11, p. 311 (specimen and 3 micro.-slides).
Streptelasma araneum *S. Smith*, pl. xxvii, figs. 12, 13, p. 316 (2 micro.-slides).
,, whittardi *S. Smith*, pl. xxvii, fig. 14 ; pl. xxviii, figs. 1-20, text-fig. 7, p. 312 (9 specimens and 16 micro.-slides).
,, crassiseptatum *S. Smith*, pl. xxvii, fig. 15 ; pl. xxviii, fig. 21, p. 315 ; text-fig. 8 (3 micro.-slides), p. 314 (3 specimens and 7 micro.-slides).
Onychophyllum pringlei *S. Smith*, pl. xxviii, figs. 22, 23, p. 301 ; text-fig. 3, p. 302 (3 specimens and 2 micro.-slides).
[Orthophyllum] sp., text-fig. 4, p. 304 (3 micro.-slides).
[Paterophyllum] praematurum *S. Smith*, text-fig. 5, p 305.
Favosites fibrilla *S. Smith*, pl. xxviii, fig. 24, p. 319 (specimen and 2 micro.-slides).
,, gothlandicus *Lamarck, forma* multipora *Lonsdale*, p. 318 (3 specimens and 2 micro.-slides).
,, asper *A. d'Orbigny*, p. 318 (2 specimens and 2 micro.-slides).
Halysites sp., p. 320 (specimen and 3 micro.-slides).
Heliolites sp., p. 321 (2 specimens and micro.-slide).
Clathrodictyon rosarium *S. Smith*, pl. xxix, figs. 1-4, p. 323 (2 specimens and 4 micro.-slides).

In the Annals and Magazine of Natural History, Volume V, Tenth Series.

The Calostylidae, Roemer : a Family of Rugose Corals with Perforate Septa.

By Dr. Stanley Smith, M.A., F.G.S.

Calostylis roemeri *S. Smith*, pl. x, figs. 1-5, p. 262 (12 specimens and 8 micro.-slides).
,, togata *S. Smith*, pl. x, figs. 6-8, p. 263 (3 specimens and micro.-slide).
,, intermediate in character between *roemeri* and *togata*, p. 264.
,, aberrans *S. Smith*, pl. x, figs. 9-17, p. 265 (7 specimens and micro.-slide).

On some Ammonoidea from the Lower Greensand.

By Dr. L. F. Spath, F.G.S.

Parahoplites simmsi (*Forbes*), *Spath*, pl. xiv, figs. 1a, b, p. 440.
,, sussexensis *Spath*, pl. xvi, fig. 1, p. 441.
,, nutfieldiensis (*J. Sowerby*), text-fig. b, p. 438.
,, *aff.* campichei (*Pictet and Renevier*), *Sinzow*, p. 439.
,, sp. juv., pl. xvi, fig. 2, p. 442.
Tonohamites proteus *Spath*, pl. xvi, fig. 7, p. 461.
Tonohamites ?, sp. nov., pl. xiv, fig. 5, p. 462.
Cheloniceras perli *Spath*, pl. xvi, fig. 6, p. 445 (3 specimens).
,, *aff.* martini (*d'Orbigny*), pl. xiv, fig. 7, p. 450.
,, hambrovi (*Forbes*), p. 444.
,, *aff.* gottschei (*Kilian*), p. 446 (2 specimens).
,, *aff.* meyendorffi (*d'Orbigny*), p. 446.
,, cornuelianum (*d' Orbigny*), p. 448 (2 specimens).
,, *cf.* crassum *Spath*, p. 449.
,, *aff.* subnodosocostatum (*Sinzow*), p. 452 (3 specimens).
Deshayesites kiliani *Spath*, pl. xv, fig. 1, p. 429 (3 specimens).
,, punfieldensis *Spath*, pl. xvi, figs. 3a, b, p. 431.
,, grandis *Spath*, pl. xvii, figs. 2a, b, p. 427 (2 specimens).
,, deshayesi (*Leymerie MS., d'Orbigny*), p. 424.
,, consobrinus (*d'Orbigny*), *var.* involuta *Spath*, p. 432.
Tropaeum sp. ind., pl. xv, fig. 2, p. 457.
Dufrenoyia truncata *Spath*, pl. xvi, fig. 4c, p. 437.
,, furcata (*J. de C. Sowerby*), p. 435.
,, furcata (*J. de C. Sowerby*) *var.*, p. 435.

In the Annals and Magazine of Natural History, Volume VI, Tenth Series.

Some Coal Measure Arthropods from the South Wales Coalfield.

By Miss E. Dix, M.Sc., F.G.S. and Mr. J. Pringle, F.G.S.

Belinurus morgani *Dix and Pringle*, text-fig. 1, p. 138.
,, bellulus *König*, text-fig. 3, p. 140.
,, *aff.* bellulus *König*, p. 140.
,, reginae *Baily*, p. 141 (3 specimens).
,, sp., p. 141.
Pygocephalus *cf.* cooperi *Huxley*, p. 143.

In the Geological Magazine, Volume LXVII.

The Generic Position and Phylogeny of some Jurassic Arcidae.

By Dr. W. J. Arkell, M.A., B.Sc., F.G.S.

Parallelodon rugosum (*J. Buckman*), pl. xiv, figs. 1-4 ; text-fig. 1, p. 299 (4 specimens).
,, rudis (*J. de C. Sowerby*), pl. xiv, fig. 5, p. 300.
Navicula (Eonavicula) minuta (*J. de C. Sowerby*), pl. xvi, fig. 5, p. 348.
,, ,, eudesi (*Morris and Lycett*), pl. xvi, figs. 6, 7 ; text-fig. 17, p. 345 (2 specimens).
,, ,, quadrisulcata (*J. de C. Sowerby*), pl. xvi, fig. 8, p. 347.

IN THE PROCEEDINGS OF THE GEOLOGISTS' ASSOCIATION, VOLUME XL.

Notes on English Eocene Boring Mollusca, with descriptions of New Species.

By MR. A. WRIGLEY.

Martesia saxorum *Wrigley*, p. 380.

IN THE PROCEEDINGS OF THE MALACOLOGICAL SOCIETY, VOLUME XIX.

Notes on Raised Beach Mollusca from the Isle of Portland.

By MR. D. F. W. BADEN-POWELL, M.A., B.Sc., F.G.S.

Anomia ephippium *Linné*, p. 68.
Chlamys distorta (*da Costa*), p. 68.
Turtonia minuta (*Fabricius*), p. 69.
Patella vulgata *Linné*, p. 69.
Patina pellucida (*Linné*), p. 70.
,, laevis (*Pennant*), p. 70.
Acmaea virginea (*Müller*), p. 70.
Diodora apertura (*Montagu*), p. 70.
Margarites helicinus (*Fabricius*), p. 70 (2 specimens).
Gibbula cineraria (*Linné*), p. 70.
,, umbilicata (*Montagu*), p. 70.
Phasianella pullus (*Linné*), p. 70.
Lacuna pallidula (*da Costa*), p. 71.
Littorina littorea (*Linné*), p. 71.
Rissoa parva (*da Costa*), p. 71.
,, subcylindrata (*Jeffreys*), p. 72.
,, sp. *near* violacea (*Desmarest*), p. 72.
Onoba striata (*J. Adams*), p. 72.
Ocenebra erinacea (*Linné*), p. 73.
Nucella lapillus (*Linné*), p. 73.
Nassarius incrassatus (*Strøm*), p. 74.
Propebela rufa (*Montagu*), p. 74.

IN THE PROCEEDINGS OF THE COTTESWOLD NATURALISTS' FIELD CLUB, VOLUME XXIII. Part 3.

The Inferior Oolite and Contiguous Deposits of the Burton Bradstock—Broadwindsor District.

By MR. L. RICHARDSON, F.R.S.E., F.G.S.

Aulacothyris cucullata *S. Buckman*, p. 256.
Zeilleria lingulata *S. Buckman*, p. 257.
,, whaddonensis *S. Buckman*, p. 260.
Lima oepybolus *Whidborne*, p. 257.
Terebratula imitator *S. Buckman*, p. 257.
,, whaddonensis *S. Buckman*, p. 260.
,, arenaria *S. Buckman*, p. 260.

IN THE MEMOIRS AND PROCEEDINGS OF THE MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, VOLUME LXXIV, SESSION 1929-1930.

III.—*Additions to the Fauna of the Lancashire Coal Measures.*

By DR. W. B. WRIGHT, M.R.I.A., M.Inst.M.E., F.G.S.

Anthracomya hindi *Wright*, pl. i, figs. 1, 1A, B, p. 44 (5 specimens)
,, hindi *Wright, var.*, p. 45.
,, richfordi *Wright*, pl. i, figs. 3, 3A, B, p. 45.

Cytherella foveolata *Wright*, pl. i, figs. 2, 2A, B, p. 49.
Carbonicola faba *Wright*, pl. i, figs. 4, 4A, B, p. 47 (3 specimens).
,, binneyi *Wright*, pl. i, figs. 5, 5A, p. 48 (2 specimens).

IN THE NATURALIST.

Shell structure of some Carboniferous Lamellibranchs.

By MISS E. DIX, M.Sc., F.G.S., AND DR. A. E. TRUEMAN, F.G.S.

? Anthracomya *cf.* phillipsi (*Williamson*), p. 16 (8 specimens).

Actinocamax *from the Upper Chalk of Yorkshire.*

By MR. A. G. BRIGHTON, M.A., F.G.S.

Actinocamax grossouvrei *Janet*, pl. v, figs. 1-5, pp. 117-120.

IN THE PROCEEDINGS OF THE ROYAL IRISH ACADEMY, VOLUME XXXIX, SECTION B, No. 26.

The Carboniferous Rocks of Hook Head, County Wexford.

By DR. L. B. SMYTH, M.A., M.R.I.A.

Schuchertella wexfordensis *Smyth*, p. 556.

IN MEMOIRS OF THE GEOLOGICAL SURVEY, ENGLAND AND WALES.

The Geology of the Maryport District.

By MR. T. EASTWOOD, A.R.C.Sc., F.G.S.

Pustula punctata (*Martin*), pl. ii, fig. 9, p. vii.
Tylonautilus nodiferus (*Armstrong*), p. 18.

IN MEMOIRS OF THE GEOLOGICAL SURVEY. SUMMARY OF PROGRESS OF THE GEOLOGICAL SURVEY OF GREAT BRITAIN AND THE MUSEUM OF PRACTICAL GEOLOGY FOR THE YEAR 1929, Part ii.

IV.—*A new Upper Cambrian Section in South Shropshire.*

By DR. C. J. STUBBLEFIELD, A.R.C.Sc.

Acrotreta sabrinae (*Callaway*), p. 58.
,, *cf.* schmalenseei *Walcott*, p. 57.
,, sp. [of the *A. idahoensis* Walcott group], p. 58.
Micromitra sp. [of the *M. sculptilis* (Meek) group], p. 57.
,, (Paterina) sp., p. 57.
,, ? sp., p. 57.
Beltella *cf.* bucephala (*Belt*), p. 57.
Orusia lenticularis (*Wahlenberg*), p. 57.
,, *cf.* lenticularis (*Wahlenberg*), p. 61.
Lingulella nicholsoni *Callaway*, p. 58.
,, *cf.* lepis (*Salter*), p. 58.
,, sp., p. 57.
Parabolinella *aff.* williamsoni (*Belt*), p. 57.
Obolus (Bröggeria) salteri (*Holl*), p. 58.
Ctenopyge flagellifera (*Angelin*), p. 58.
,, ,, *var.* angusta *Westergård*, p. 58.
Eurycare angustatum *Angelin*, p. 58.
Leptoplastus *cf.* stenotus *Angelin*, p. 58.
,, sp., p. 58.

Tomaculum problematicum *Groom*, p. 58.
Euloma monile (*Salter*), p. 58.
Dictyonema flabelliforme (*Eichwald*), p. 59.
,, ,, *var.* sociale (*Salter*), p. 58.
Parabolina spinulosa (*Wahlenberg*), *var.*, p. 59.

VI.—Edestus pringlei *sp. nov.*

By Professor D. M. S. Watson, F.R.S.

Edestus pringlei *Watson*, text-fig. 1A-F, p. 73 (3 specimens).
Lateral tooth of "*Campodus*" type, text-fig. 1G, p. 73.

In Memoirs of the Geological Survey. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1929, Part iii.

I.—*Pliocene Sandstone from Rothamsted (Hertfordshire).*

By Mr. H. G. Dines, A.R.S.M., A.M.Inst.C.E., and Mr. C. P. Chatwin, M.Sc.

2. *The Age of the Sandstone.*

By Mr. C. P. Chatwin.

Pholas (Barnea) cylindrica *J. Sowerby*, pl. i, figs. 1-9, p. 5 (7 specimens).
Mytilus edulis *Linnaeus*, pl. i, figs. 10-12, p. 5 (3 specimens).
Modiola barbata (*Linnaeus*), pl. i, fig. 13, p. 5.
Cardium parkinsoni *J. Sowerby*, pl. i, figs. 14, 15, p. 6 (2 specimens).
,, (Cerastoderma) edule *Linnaeus*, pl. i, fig. 16, p. 6.
Tellina ?, pl. i, fig. 17, p. 6.
Nassa granulata *J. Sowerby*, pl. i, figs. 18, 19, p. 6 (2 specimens).
Bullinella ?, pl. i, figs, 20, 21, p. 5.
Ensis ensis (*Linnaeus*), p. 5 (2 specimens).
Pectunculus glycimeris (*Linnaeus*), p. 6.
Modiolaria costulata (*Risso*), p. 6 (2 specimens).
Natica sp., p. 6.
Balanus sp., p. 6 (13 specimens).

II.—*Further Morphological Studies in* Palaeoxyris, *etc.*

By Dr. R. Crookall.

Palaeoxyris pringlei *Crookall*, p. 19.
,, carbonaria *Schimper*, pl. ii, figs. 5, 6, p. 19 (3 specimens).
,, trispiralis *Kidston*, p. 18.
Fayolia cambriensis *Crookall*, pl. iii, figs. 2a, b, p. 23.
,, crenulata *Moysey*, pl. ii, fig. 2, p. 27.
Vetacapsula moyseyi *Crookall*, p. 29.
,, hemingwayi *Crookall*, pl. ii, fig. 8, p. 29.
,, cooperi *Mackie*, pl. ii, fig. 7, p. 31.

VII.—*On the Goniatite and Nautiloid Fauna of the Middle Coal Measures of England and Wales.*

By Mr. W. S. Bisat, F.G.S.

Anthracoceras hindi *Bisat*, p. 78.
,, cambriense *Bisat*, pl. vii, figs. 5, 6, p. 78 (14 specimens).
,, aegiranum *H. Schmidt*, pl. vii, figs. 7, 8, p. 79 (2 specimens).

Homoceratoides jacksoni *Bisat*, pl. vii, fig. 2, p. 80 (4 specimens).
,, kitchini *Bisat*, pl. vii, figs. 3, 4, p. 81 (8 specimens).
Gastrioceras *aff.* globulosum (*Meek and Worthen*), p. 82.
Dimorphoceras ?, p. 82 (2 specimens).
Metacoceras *cf.* perelegans *Girty*, pl. viii, figs. 7, 8, p. 83 (6 specimens).
,, *aff.* cornutum *Girty*, pp. 83, 84 (2 specimens).
,, postcostatum *Bisat*, pl. vii, figs. 10-12, p. 85 (6 specimens).
,, rotifer (*Salter*), p. 85 (2 specimens).
Cyclonautilus dubius *Bisat*, pl. viii, figs. 10, 11, p. 85 (6 specimens).

B. Scotland

During the summer Mr. Eckford visited the Shetland Islands and was successful in obtaining a fine series of fish-remains from the Old Red Sandstone. Some of the fishes are from two new localities found by him, and he also obtained additional specimens from the locality discovered by Sir J. S. Flett many years ago. Further material, too, was collected from the fish-bearing beds described by Dr. T. M. Finlay in his paper on the Old Red Sandstone of Shetland.[1] The specimens were submitted to Prof. D. M. S. Watson, F.R.S., who, after a preliminary examination, found them to show features of special interest. The collection includes several new species, which are being further investigated.

Amongst the material collected from the roofs of various coals in the district of New Cumnock, Ayrshire, Mr. W. D. Fisher obtained many fine examples of *Carbonicola*, *Naiadites*, and *Anthracomya*. A selection of these shells, identified by Prof. A. E. Trueman, has been incorporated in a set designed to illustrate the zonal scheme of Messrs. Trueman and Davies. From the well-known marine band at The Den, East Wemyss, Fife, Mr. Fisher also obtained several fine examples of *Metacoceras costatum* (Hind), a shell characteristic of the Gin Mine Marine Bed of North Staffordshire. The section at East Wemyss is now practically worked out.

In connexion with the reference-set of Mollusca from the Coal Measures, Mr. Pringle investigated the specimens recorded as *Naiadites crassa* and *N. modiolaris* from the roof of the Jewel Coal, a seam which lies near the base of the Limestone Coal Group of the Scottish Carboniferous Limestone Series in Midlothian. He examined a large number of these shells and found that they should be referred to a single species, which, however, is new and awaits description. Several well preserved specimens were collected by Mr. Tait from the Lady Victoria Pit at Newtongrange, near Dalkeith.

Reference has been made above, in the Report of the Director (p. 28), to the large collection of geological specimens presented to the Scottish branch of the Geological Survey by the late John Smith of Dalry, Ayrshire. Mr. Smith was one of the best known of a group of enthusiastic Scottish amateur geologists, whose united efforts have made notable contributions to the science in Scotland. For a period of more than 50 years he devoted himself to research among

[1] *Trans. Roy. Soc. Edin.*, vol. liv, 1926, p. 553.

the rocks of that country, paying particular attention to the geology and archaeology of North Ayrshire, and in the course of his work he amassed a magnificent collection of fossils, rocks, and minerals. The Carboniferous fossils are particularly valuable ; most of them have at one time or another been in the hands of well-known specialists, such as Kidston, Wheelton Hind, Ivor Thomas and G. W. Lee, who figured many of the plants and shells.

Many years ago Mr. Pringle suggested that Coal Measures were likely to be found in the Thornhill area (Dumfriesshire). During a recent visit to the district with Mr. J. E. Richey, he was able to confirm that Coal Measures occur there, where previous mapping had recorded only Lower Carboniferous rocks (see also p. 60). Mr. Richey and Mr. Pringle were successful in obtaining a series of fossils, including *Carbonicola* and typical plants. An account of this discovery will appear in a subsequent part of the present *Summary of Progress*.

F. L. KITCHIN.

2. PALAEOBOTANICAL WORK

Identifications of fossil plants have been made during 1930 by the Palaeobotanist from one-inch Sheets 23, 86, 87, 152, 231, 273, 289, 290, 298, 299 (England) and from one-inch Sheets 8, 9, 14, 15, 20, 21, 39, 41 (Scotland) as well as from a number of sinkings and boreholes. Determinations have also been made for other Museums, Universities and private collectors.

Specimens of peat from Southampton Docks and fossil woods from several localities (including a gravel-pit at Corfe Mullen, Dorset and Beedon Hill, near Oxford) have been examined and reported upon. A piece of wood from the Pitch Lake at Trinidad, sent in to the Museum, proved to be recent and was passed on to Dr. Boulton, Cambridge, for detailed examination. A description has been prepared of a specimen of *Dadoxylon* from the Barren Red Measures of Ayrshire at Auchinleck, Ayrshire, for inclusion in the forthcoming memoir.

Field work has included several visits to the Kent coalfield and one to the Bristol and Somerset coalfield. The specimens collected, including a large number of new records, have been identified and reports on the palaeobotany of the Coal Measures prepared.

The plant-lists in the various Survey publications passing through the press have been checked. Assistance has been given to outside workers in the identification of fossils, the editing of papers and in providing bibliographies.

The Palaeobotanist has conferred with the officers of the Fuel Research Station on the occurrence of spores in coal and has provided them with fragments of cones for the extraction of spores, photographs of cones and spores, and samples of coal from each of the Kent pits (for sectioning) and has received from them spores, diagrams and photomicrographs for use in the coal exhibit.

During the year Dr. Crookall attended the Fifth International Botanical Congress at Cambridge and the meeting of the British Association at Bristol, providing an exhibit in each case.

In the Museum, with the assistance of Mr. C. H. Benson, internally illuminated cases have been added to the coal exhibit showing: (1) the micro-structure of coal, (2) coal-balls, their nature and origin, (3) transparencies made from negatives loaned by Mr. H. W. Hughes of Dudley of underground working for coal, (4) transparencies showing the occurrence of peats, lignites and humic coals in Britain, (5) cellulose ' pulls ' of coal-balls illustrating the connection between these petrified remains and the lithological constituents of humic coals. A floor-case has also been prepared dealing with those Coal Measures plants which went to form coal.

For the new Museum, an outline account of the geology of the Bristol-Gloucester area has been prepared, together with the plan of an exhibit.

Exhibits have been made up for the Geological Society, the Geologists' Association, the International Botanical Congress and the British Association and a number of demonstrations given in the Museum. The exhibits included (1) specimens of *Crossotheca* (the nature of which is under discussion), (2) diagrams showing the stratigraphical distribution of British Carboniferous plants, (3) diagrams of the classification of British Carboniferous rocks, (4) recently published Survey maps and memoirs, (5) photographs illustrating the occurrence of coals, (6) prints made from negatives in the Kidston Bequest.

Professional assistance has been received from Mr. W. D. Ware of Swansea in connection with the Coal Measures of the Merthyr district (at present under revision). Mr. Ware has discovered in the base of the Coal Measures plants which strongly suggest correlation with the lowest measures of Scotland, Yorkshire and elsewhere.

Mr. E. G. Radley has completed the printing of the 4,000 negatives of fossil plants in the Kidston Bequest. Two prints have been made from each negative, one being mounted and the other stored for use in the projected continuation of the Kidston Memoir. The mounted photographs are arranged alphabetically according to species and placed in a cabinet for ready reference. They have already proved of considerable value both to the staff and to visiting research workers. Mr. Radley has also completed card catalogues of the specimens in the Kidston Collection (7,000 specimens) and of the fossil plants in charge of the Palaeobotanist (1,100 specimens). In addition, he has made a number of negatives and prints.

The following specimens in the Kidston Collection have been figured during the year :

IN ANNALS OF BOTANY, VOL. XLIV, NO. CLXXV, JULY, 1930.

'Crossotheca *and* Lyginopteris oldhamia.'

By R. CROOKALL.

Sphenopteris hoeninghausi *Brongniart*, pl. xxxiv, fig. 8, pp. 625, 636. (specimen No. 939).
,, ,, ,, pl. xxxiv, fig. 9, pp. 625, 636. (specimen No. 940).
,, ,, ,, pl. xxxiv, figs. 13, 20, pp. 625, 637. (specimen No. 5174).
,, ,, ,, pl. xxxiv, fig. 14, pp. 624, 637. (specimen No. 924).

The following specimens have been mentioned :

IN JAARVERSLAG OVER 1929, GEOLOGISCH BUREAU VOOR HET NEDERLANDSCHE MIJNGEBIED TE HEERLEN, 1930.

'*On the Fructification of* Sphenopteris hoeninghausi *and its relations with* Lyginodendron oldhamium *and* Crossotheca schatzlarensis' (*Preliminary Note*).

By W. J. JONGMANS.

(The identifications here given are those of Kidston. Some of these are queried by the author).

Crossotheca hoeninghausi (*Brongniart*), p. 78 (specimens No. 936, 937).
,, ,, ,, p. 79 (specimens No. 938, 940, 3218, 4722, 5174).
,, schatzlarensis (*Stur*), p. 79 (specimens No. 899, 900, 1405, 1957, 2037, 2040).
,, communis (*Lesquereux*), p. 79 (specimens No. 2081, 2083).
Lyginodendron landsburgi *Gourlie*, p. 80 (specimen No. 3220).

R. CROOKALL.

3. PETROGRAPHICAL WORK

The work of the Petrographical department has been mainly connected with the districts undergoing re-survey, supplemented by that imposed upon the department by outside enquiry. In England the completion of the survey of the Cheviot granite and associated lavas and dykes has involved the revision of all the collected material for the purpose of the forthcoming memoir on the district. It has been established beyond reasonable doubt that the normal Cheviot granite is a soda-rich granophyric granite almost devoid of ferromagnesian constituents, and that the so-called augite-granite owes its unusual characters to the incomplete assimilation of basic material derived from the andesitic lavas. It can be demonstrated that the major part of the exposed granite is of marginal character, portions of its original roof remaining well within its boundary, and thus quite prone to contamination by the adjacent country rock. It may be that the andesite lavas having a microporphyritic structure and a glassy base were easily disintegrated and readily gave a xenocrystal character to the invading granite. In view of the widespread tourmalinization of certain portions of the granite, alluvium from streams draining this area was panned and the concentrates examined for tin, but with negative results.

In Shropshire a similar revision of all material from such areas as the Wrekin, Pontesford Hill, etc., has been made for the purposes of the memoir now in hand, the work being carried out by Messrs. Whitehead and Pocock with assistance from the Petrographer.

In Scotland Mr. A. G. MacGregor has continued his work on the Old Red Sandstone and Carboniferous igneous rocks of Ayrshire and Renfrewshire, while Dr. H. H. Read has made himself responsible for the petrology of the Sutherlandshire region.

The Director has dealt with the petrology of the dyke rocks and other intrusive masses of the Orkney and Shetland Islands.

For a considerable portion of the year Miss E. M. Guppy and the Petrographer were engaged in compiling a memoir on the igneous and metamorphic rocks and minerals analysed by the Geological Survey. The analyses have been tabulated and classified and corresponding petrographical descriptions given.

As usual many enquiries of archaeological interest have been dealt with such as the identification of rocks used for vessels and other objects from Ur, and other sites. An interesting record of Niedermendig tephrite has been made from a prehistoric site known as the Sanctuary, south of Avebury, in Wiltshire in the course of excavations made by Mrs. Cunnington of Devizes. This rock has not

previously been recorded with certainty in Britain from any pre-Roman site but in Roman times it was liberally imported into Britain for the purpose of millstones.

Mr. Reid Moir of Ipswich discovered an extensive bank of waterworn fragments of basic igneous rock in the area of the Wash off Hunstanton. This rock proved to be identical with the Whin Sill, and probably the great number of rolled fragments and pebbles results from the destruction of some artificial barrier of imported whin-stone placed there in an ancient attempt at reclamation.

HERBERT H. THOMAS.

4. CHEMICAL WORK

The quantitative analyses completed during 1930 were mainly for the Scottish memoirs and include the following :

899. *Basaltic Mugearite.* Non-porphyritic lower portion of composite lava flow of Calciferous Sandstone age. Lower portion of same flow as 900. West scarp of Dunrod Hill, 800 ft. contour, 250 yds. E.30°S. of foot-bridge over aqueduct. 6-inch map, Renfrew, 1 S.E. Slice No. S 27217.

900. *Porphyritic Basalt* near Markle type. Coarse porphyritic upper portion of composite lava flow of Calciferous Sandstone age. Upper portion of same flow as 899. Locality as for 899. 6-inch map, Renfrew, 1 S.E. Slice No. S 27219.

901. *Albite-diabase.* N. of Lendalfoot, E. side of road, in field. 6-inch map, Ayr, 61 N.W. Slice No. S 27360.

902. *Albite-diabase.* W. side of road, 200 yds. N. of Chapman's Craig, S. of Lendalfoot. 6-inch map, Ayr, 61 N.W. Slice No. S 27361.

903. *Hornblende-schist.* 800 yds. N.18°E. of Bougang, 2 mls. W. by S. of Colmonell. 6-inch map, Ayr, 66 N.W. Slice No. S 27363.

904. *Anorthosite* with prehnite etc. Intrusive; S. end of Fell Hill, 1300 yds. S.E. of Ardwell. 6-inch map, Ayr, 55 S.E. Slice No. S 27365.

Lab. Nos.	899	900	901	902	903	904
SiO_2	48.40	47.71	46.47	47.50	45.70	56.31
Al_2O_3	16.66	18.09	12.87	12.39	13.60	22.70
Fe_2O_3	8.54	8.57	2.40	4.17	2.32	0.09
FeO...	2.85	2.61	11.68	10.60	9.47	1.16
MgO	4.85	4.45	5.48	4.27	10.53	0.54
CaO	7.44	8.52	9.97	7.37	10.08	9.89
Na_2O	3.42	3.58	4.00	4.88	3.74	6.33
K_2O	1.76	1.68	0.68	0.89	0.56	0.75
$H_2O > 105°$ ...	1.19	1.12	2.56	2.62	1.19	1.70
$H_2O < 105°$ ...	1.23	1.00	0.06	0.20	0.01	0.14
TiO_2	3.06	2.52	3.69	4.49	2.60	0.27
P_2O_5	0.49	0.41	0.50	0.78	0.26	0.35
CO_2	0.00?	0.00?	0.00?	0.00?	0.00?	0.00?
FeS_2	0.07	0.07	0.09	0.02	0.08	0.07
Cr_2O_3	—	—	0.02	0.00?	0.14	—
Li_2O	0.00?	0.00?	—	—	—	—
Totals ...	99.96	100.33	100.47	100.18	100.28	100.30
Analysed by ...	B. E. Dixon.					

897. *Carbonaceous or Bituminous Limestone.* ("Stinkstone"?). Concretion in Black Upper Cambrian Shales. Bank of tributary to E. bank of Bentleyford Brook, 700 yds. S.E. by E. of Bentleyford, Shropshire. 1-inch map, Eng., 152.

898. *Phosphorite.* Concretion in Black Upper Cambrian Shales. Locality as for 897. 1-inch map, Eng., 152. Slice No. E 15140.

Lab. Nos.	897	898
SiO_2	6.56	10.3
Al_2O_3	1.56	15.8
Fe_2O_3 }	0.87	3.9
FeO }		
MgO	0.24	0.4
CaO	47.69	36.7
Na_2O	0.14	0.4
K_2O	0.55	0.7
TiO_2	0.17	0.2
P_2O_5	0.75	14.3
CO_2	37.04	0.0?
F	—	1.4
FeS_2	1.20	1.7
V_2O_3	0.01	—
Water and organic matter	2.97	13.8
Less O for F.	—	0.6
Totals	99.75	99.0
Analysed by	B. E. Dixon.	

In the cases of Lab. Nos. 897, 898, difficulties in the estimation of water, carbon, and total sulphur were caused by the presence of a considerable amount of carbon in various states of combination, including a small amount of a constituent extractable by organic solvents. The usual methods for the determination of total or hygroscopic water involve the direct or indirect measurement of the water expelled on heating. Lack of agreement in the results obtained by these methods, even when precautions were taken to avoid oxidation of the organic matter, was found to be due to the ready volatility of this organic constituent. In the case of Lab. No. 897 the total water amounts to about 1%.

B. E. Dixon.

IV. MUSEUM OF PRACTICAL GEOLOGY

The total attendance of visitors for the year was 21,081 ; of these 1,611 were Sunday visitors. Thirty demonstrations to parties from schools, scientific and technical institutions were given, the total attendance at these being 520.

During the year the museum staff have been largely occupied with the plans of the lay-out in the new museum at S. Kensington, now in course of erection. Details of the various sectional displays designed for the new galleries have been worked out and considerable progress has been made in the selection of photographs, maps, illustrations and specimens for the Ground Floor exhibits which are intended to illustrate the general principles of geology. Coincidently with this work the existing gemstone collection is being completely re-arranged ; material in the reserve collections has been incorporated and case plans prepared. By this procedure it is intended that the display collections may be installed with the least possible delay on completion of the new building. The work has been carried on so far with the minimum of disturbance to the existing exhibited collections which will remain available to the public as long as possible.

Plans of the exhibits for the first and second galleries, devoted respectively to the Geology of Great Britain and to Economic Geology, are now well advanced and the work of assembling the material for the various sections is about to be put in hand.

Exhibits illustrating the work of the Survey were prepared for the British Association Meeting at Bristol and for the Annual Conversazione of the Geologists' Association.

Cataloguing and registration have been carried on steadily. The registration of the minerals in the Lindsey Collection has been completed, 4,665 specimens having been taken on the inventory, labelled and card-indexed.

A considerable programme of geophysical field work has been carried out during the year. Magnetic surveys were made at Portobello and Blairgowrie in Scotland and at Groby, Leicestershire and at Pipewell, Northants. A complete survey with the recently acquired small Eötvös-Süss Torsion Balance was carried out over the magnetic anomaly at Thrussington, Leicestershire, described by Mr. Hallimond.[1] The results are at present in process of preparation for publication.

The Library continues to be used to an increasing extent by students, research workers and members of the general public. The additions during the year comprise 289 volumes of independent works, 3,098 volumes and parts of serials, 201 pamphlets, 767 maps and 515 geological photographs ; 373 photographic prints and 257 lantern slides were supplied to public order.

W. F. P. McLintock.

[1] Hallimond, A. F. H., 'On the Magnetic Disturbances in North Leicestershire,' 'Summary of Progress' for 1929, Pt. ii, (*Mem. Geol. Surv.*) 1930, p. 16.

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